W. B. No. 938

UNITED STATES DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

VOLUME 55 NUMBER 10

MONTHLY WEATHER REVIEW

OCTOBER, 1927

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UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1927

MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY

Vol. 55, No. 10
W. B. No. 938

OCTOBER, 1927

CLOSED DEC. 3, 1927
ISSUED DEC. 30, 1927

FRANKENFIELD ON THE 1927 FLOODS IN THE MISSISSIPPI VALLEY[1]

By A. J. HENRY

CAUSES OF FLOODS OF 1927

During the second week of August, 1926, a period of general rains set in over the portion of the central drainage basin of the Mississippi River, extending from eastern Kansas and eastern Oklahoma east-northeastward throughout the Ohio Valley. By the end of that month the soil over that area was well saturated with moisture and the continuance of heavy rains through September and early October caused general floods except in the Ohio where flood stages were not reached although high water prevailed. In portions of the Neosho Valley of Kansas and in the lower Illinois Valley the floods were the greatest and most disastrous of record, and it was not until November 20 that the entire Illinois River had fallen below flood stage. The foundation was thus so well laid that neither prophetic vision nor vivid imagination was required to picture a great flood in the following spring, contingent only upon a rainfall substantially above the normal during the winter months. October, November, and early December are normally the months of lowest water in the rivers of the United States, yet in October and November, 1926, nearly all of the main and tributary rivers below the mouth of the Platte and Des Moines Rivers were well above the normal stages for the season, with the channels of many of the larger streams filled to at least 50 per cent of their natural capacity. While there may have been some room for speculation even as late as December 15, the great flood in the Tennessee and the record-breaking flood in the Cumberland of late December, 1926, and early January, 1927, left no further opportunity for doubt. There *would* be a lower Mississippi flood and probably an Ohio flood, and its extent would be measured only by the quantity of winter rainfall and its distribution in time and space.

Since the lower Mississippi flood of 1922 up to that time the highest of record from the mouth of the Arkansas southward the mean stages for October and November and the first 15 days of December, 1912, 1921, and 1926, for a number of representative stations have been set forth in Table 1. The period was ended with December 15 as the first heavy rains set in a few days later.

A cursory inspection of this table will show clearly that with winter rainfall in excess to only a moderate degree, a flood equalling or exceeding that of 1922 might reasonably be expected in the spring of 1927. The figures for 1912, a year of large flood were added with the idea of affording further illumination in connection with the question of the possible maximum flood of the future.

The outstanding features of the above table are the large 1926 excesses in stage in the Mississippi below the mouth of the Missouri, and in the Illinois, lower Arkansas and lower White Rivers, the relatively large excesses in the Mississippi at Hannibal, Mo. Note also at this time for later reference in connection with future flood possibilities that the excess in the Ohio above Paducah was not very significant. On the whole, however, the antecedent conditions in the autumn of 1926, by reason of the much higher stages over the major portion of the potential flood area, were at least suggestive of as great a flood in the spring of 1927 as in tne spring of 1922. Their relative magnitude could be determined only by the amount and distribution of the winter rains over the great central valleys.

TABLE 1.—*Average river stages October 1 to December 15, 1912, 1921, and 1926*

Station	River	Flood stage	1926	1912	Excess, 1926 over 1912	1921	Excess, 1926 over 1921
		Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Pittsburgh, Pa.	Ohio	[1] 25	14.6	6.3	8.3	11.4	3.2
Cincinnati, Ohio	do	52	24.9	12.2	12.7	20.8	4.1
Evansville, Ind.	do	35	22.0	14.3	7.7	17.3	4.7
Nashville, Tenn.	Cumberland	40	14.2	6.1	8.1	11.9	2.3
Johnsonville, Tenn.	Tennessee	31	5.0	1.9	3.1	4.8	0.2
Paducah, Ky.	Ohio	43	21.7	16.0	5.7	14.8	6.9
Cairo, Ill.	do	45	31.6	18.9	12.7	21.2	10.4
Hannibal, Mo.	Mississippi	13	9.0	5.5	3.5	4.0	5.0
Beardstown, Ill.	Illinois	14	20.3			10.4	9.9
Tuscumbia, Mo.	Osage	25	10.6			4.1	6.5
Hermann, Mo.	Missouri	21	10.8	4.5	6.3	5.4	5.4
St. Louis, Mo.	Mississippi	30	18.2	10.8	7.4	6.1	12.1
New Madrid, Mo.	do	34	24.3	16.6	7.7	15.2	9.1
Memphis, Tenn.	do	35	23.8	14.4	9.4	13.7	10.1
Helena, Ark.	do	42	30.0	20.8	9.2	16.9	13.1
Clarendon, Ark.	White	30	22.0	13.0	9.0	12.5	9.5
Pine Bluff, Ark.	Arkansas	25	14.4	7.9	6.5	5.7	8.7
Arkansas City, Ark.	Mississippi	48	35.1	23.9	11.2	18.9	16.2
Vicksburg, Miss.	do	45	32.8	24.3	8.5	16.6	16.2
Alexandria, La.	Red	36	12.1	11.6	0.5	3.9	8.2
Monroe, La.	Ouachita	40	13.9	11.2	2.7	5.1	8.8
Baton Rouge, La.	Mississippi	35	22.7	16.4	6.3	9.5	13.2
New Orleans, La.	do	17	9.6	7.4	2.2	3.3	6.3
Melville, La.	Atchafalaya	37	26.3	15.8	10.5	13.8	12.5

[1] On Mar. 1, 1926, the zero mark of the river gage at Pittsburgh, Pa., on the Ohio River was lowered from 697.2 to 694 feet above mean sea level in order that the recorded stages might show the actual height of the water above the bottom of the pool created by the fixed dam 6 miles downstream at Emsworth, Pa. This necessitated a correction of plus 3.2 feet to all gage records previous to Mar. 1, 1926, and this correction should be applied to all data for Pittsburgh previously published. The highest authenticated stage at Pittsburgh will therefore be 41.1 feet on Jan. 9, 1763, and the next 39.2 feet on Jan. 9, 1762. Flood stage at Pittsburgh is now 25 feet. On Feb. 10, 1832, the crest stage was 38.2 feet, and during this flood the Ohio River at Cincinnati reached a stage of 64.2 feet on Feb. 19, flood stage being at 52 feet.

Snow cover.—As in 1922, it appears that the influence of melted snow upon the floods of 1927 was negligible. During the Ohio flood of the third week of January, 1927, there was melting of an average cover of perhaps 4 or 5 inches north of the Ohio, but the total water contributed to the main streams could not have exceeded one-half inch, and by the end of February there was no remaining snow of consequence over any portion of the Mississippi drainage except over high mountains, and these conditions prevailed quite generally during March.

Flood increments.—As the flood of 1927 below the mouth of the Yazoo represented the total effect not only of the original great flood but also that of several other important but less decided rises, an attempt has been made to show in one table the stages and dates of these secondary rises. (See Table 2.)

[1] Condensed from the full report, Mo. Wea. Rev. Supplement No. 29, by H. C. Frankenfield and others. Copies of this report can be had from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the price of 25 cents.

TABLE 2.—*Flood crests, with dates, for 1927, in chronological order*

Station	River	Flood stage	Crest		Lowest between crests		Crest		Lowest between crests		Crest		Lowest between crests	
			Height	Date	Height	Date	Height	Date	Height	Date	Height	Date	Height	Date
		Feet	*Feet*		*Feet*		*Feet*		*Feet*		*Feet*		*Feet*	
Cincinnati, Ohio	Ohio	52	46.3	Dec. 29	11.7	Jan. 15	50.1	Jan. 25	27.4	Feb. 17	46.8	Feb. 27	21.9	Mar. 9.
Nashville, Tenn	Cumberland	40	56.2	Jan. 1	8.8	Jan. 18	31.5	Feb. 4	16.5	Feb. 15	31.4	do	14.6	Mar. 7.
Johnsonville, Tenn	Tennessee	31	41.0	Jan. 3-4	6.9	Jan. 19-20	20.2	Feb. 7	15.8	Feb. 13-14	25.4	Mar. 4	20.4	Mar. 7.
Paducah, Ky	Ohio	43	46.8	Jan. 6	15.6	Jan. 18-19	44.2	Feb. 6	31.7	Feb. 24	37.0	Mar. 4-5	33.4	Mar. 11.
Cairo, Ill	do	45	48.9	Jan. 7	23.6	Jan. 18	48.9	Feb. 6-7	38.0	Feb. 25	41.7	Mar. 5-6	39.0	Mar. 11-12.
St. Louis, Mo	Mississippi	30					17.1	Feb. 10-11	11.0	Mar. 7				
New Madrid, Mo	do	34	37.5	Jan. 8-9	18.3	Jan. 19	37.6	Feb. 8	29.3	Feb. 26	32.1	Mar. 6-7	30.2	Mar. 12.
Memphis, Tenn	do	35	37.7	Jan. 12	20.9	Jan. 22	37.8	Feb. 12-13	30.3	Mar. 1-2	32.7	Mar. 9-10	32.4	Mar. 11
Clarendon, Ark	White	30	27.7	Jan. 3-4	23.8	Jan. 20	32.6	Feb. 4-5	23.9	Mar. 7				
Helena, Ark	Mississippi	44	46.3	Jan. 15	31.0	Jan. 24	47.3	Feb. 15	30.5	Mar. 5-6				
Little Rock, Ark	Arkansas	23	20.5	Jan. 26					4.0	Feb. 28-Mar. 1.				
Arkansas City, Ark	Mississippi	48	48.7	Jan. 18	42.2	Jan. 26	51.8	Feb. 17-19	45.3	Mar. 8-10				
Greenville, Miss	do	42	41.7	Jan. 19	35.8	Jan. 27	44.8	Feb. 17-20	38.4	Mar. 8-11				
Yazoo City, Miss	Yazoo	25	30.4	Jan. 21	28.3	Feb. 10-11	29.9	Feb. 18	28.1	Mar. 7-8				
Vicksburg, Miss	Mississippi	45	46.5	do	43.3	Jan. 30-31	49.5	Feb. 21-24	45.9	Mar. 12				
Natchez, Miss	do	46	45.4	Jan. 22-24	43.4	Jan. 31-Feb. 2.	49.5	Feb. 23-27	46.7	Mar. 16-18				
Alexandria, La	Red	36	32.7	Jan. 1-2	18.4	Jan. 19	30.6	Feb. 3-4	20.3	Mar. 3				
Monroe, La	Ouachita	40	34.3	Jan. 12-14	32.0	Feb. 3-5	35.2	Feb. 20-22	32.6	Mar. 7	40.9	Mar. 28	40.1	Apr. 8.
Baton Rouge, La	Mississippi	35	34.8	Jan. 26	33.7	do	39.0	Feb. 28	37.2	Mar. 18-19				
Donaldsonville, La	do	28	27.7	do	26.5	Feb. 3-4	31.1	Mar. 1	29.4	Mar. 17-20				
New Orleans, La	do	17	16.6	Jan. 24-27	16.0	Feb. 3-6	18.8	do	17.7	Mar. 14-20				
Melville, La	Atchafalaya	37	35.8	Jan. 26-29	35.5	Feb. 1-5	30.0	Feb. 28-Mar. 2.	38.5	Mar. 12-13				

Station	River	Flood stage	Crest		Lowest between crests		Crest		Lowest between crests		Crest		Lowest between crests	
			Height	Date	Height	Date	Height	Date	Height	Date	Height	Date	Height	Date
		Feet	*Feet*		*Feet*		*Feet*		*Feet*		*Feet*		*Feet*	
Cincinnati, Ohio	Ohio	52	33.1	Mar. 14			46.0	Mar. 26	27.3	Apr. 1	39.3	Apr. 13	22.3	Apr. 29.
Nashville, Tenn	Cumberland	40	40.0	do	11.6	Mar. 31					30.4	Apr. 14	10.5	May 5.
Johnsonville, Tenn	Tennessee	31	36.3	Mar. 16	12.5	Mar. 30-31					32.0	Apr. 17	15.4	Apr. 27.
Paducah, Ky	Ohio	43	44.6	Mar. 25	41.4	Mar. 31					47.2	Apr. 18	30.9	May 9.
Cairo, Ill	do	45	52.8	Mar. 25	49.2	do					56.4	Apr. 20	41.8	Do.
Kansas City, Mo	Missouri	22	11.4	Mar. 22	9.7	Mar. 26	15.0	Apr. 2	12.6	Apr. 7	24.8	Apr. 21	15.3	Apr. 29.
Hannibal, Mo	Mississippi	13					16.5	Apr. 4	13.8	Apr. 10	18.0	Apr. 22	10.7	May 9.
St. Louis, Mo	do	30	27.3	Mar. 21-22	20.3	Mar. 31	31.0	Apr. 5	28.2	do	36.1	Apr. 26	23.7	May 7.
New Madrid, Mo	do	34	40.4	Mar. 25-26	38.4	Apr. 1-2					43.5	Apr. 21-22	34.1	May 10.
Memphis, Tenn	do	35	41.4	Mar. 30	39.8	Apr. 5					46.0	Apr. 23		
Clarendon, Ark	White	30					28.9	Apr. 1-2	28.5	Apr. 7-8	43.3	do		
Helena, Ark	Mississippi	44	51.0	Apr. 1-2	50.5	Apr. 6-8					56.75	Apr. 26-27		
Little Rock, Ark	Arkansas	23					17.5	Mar. 25	7.5	Apr. 1-2	33.0	Apr. 20	13.0	May 9.
Arkansas City, Ark	Mississippi	48									60.5	Apr. 21		
Greenville, Miss	do	42									54.7	do		
Vicksburg, Miss	do	45									58.7	May 4		
Natchez, Miss	do	46									56.5	May 1-4		
Alexandria, La	Red	36					34.6	Mar. 17-19	23.9	Apr. 5	42.4	May 8		
Monroe, La	Ouachita	40									48.2	May 4		
Baton Rouge, La	Mississippi	35									47.8	May 15		
Donaldsonville, La	do	28									37.1	May 15-17		
New Orleans, La	do	17	21.0	Apr. 25	20.2	May 10					20.7	May 15		
Melville, La	Atchafalaya	37									46.8	May 14-16		

Station	River	Flood stage	Crest		Lowest between crests		Crest		Lowest between crests		Crest		Lowest between crests	
			Height	Date	Height	Date	Height	Date	Height	Date	Height	Date	Height	Date
		Feet	*Feet*		*Feet*		*Feet*		*Feet*		*Feet*		*Feet*	
Cincinnati, Ohio	Ohio	52	32.9	May 5	17.0	May 17	35.0	May 24	25.0	May 29	31.3	June 2	16.3	June 15.
Nashville, Tenn	Cumberland	40									26.9	June 4	9.9	June 17.
Johnsonville, Tenn	Tennessee	31									15.8	June 7		
Paducah, Ky	Ohio	43	32.5	May 14	23.4	May 22					39.9	June 8		
Cairo, Ill	do	45	44.0	do	36.4	May 22-23					49.7	do		
Kansas City, Mo	Missouri	22	21.8	May 18	14.5	May 27-28								
Hannibal, Mo	Mississippi	13	15.7	May 26	13.9	June 2					17.0	June 6		
St. Louis, Mo	do	30	30.3	May 11	24.9	May 24								
New Madrid, Mo	do	34	34.8	May 14-15	29.4	do					39.4	June 10-11		
Memphis, Tenn	do	35			30.7	May 27					39.0	June 14-15		
Clarendon, Ark	White	30			28.0	May 25-26					29.3	June 15-16		
Helena, Ark	Mississippi	44			40.9	May 30-31					48.0	June 16-18		
Little Rock, Ark	Arkansas	23	17.0	May 12	9.8	May 20					19.8	June 25		
Arkansas City, Ark	Mississippi	48			43.4	June 3-4					45.4	June 20-22		
Greenville, Miss	do	42			36.9	June 1					38.6	June 20-21		
Yazoo City, Miss	Yazoo	25	37.4	June 5										
Vicksburg, Miss	Mississippi	45			47.4	June 12-14					48.7	June 25-28		
Natchez, Miss	do	46			47.6	June 16-21					47.9	June 26		
Alexandria, La	Red	36			16.1	June 20					21.4	June 26-27		

It so happened that owing to numerous crevasses, these supplementary rises did not result in increased crests in the lower river, yet they served to prolong the flood below and, what was much more unfortunate, to reinundate large areas from which the waters had receded and in much of which crops had been planted.

Rainfall and flood progress.—As the progress of a flood depends almost entirely upon the amount of precipitation, its distribution in time and space, another table has been prepared showing the amount of precipitation by weeks over the entire drainage area, beginning with December 18, 1926, and ending with April 30, 1927. (See Table 3.)

December, 1926.—The December rains were especially heavy over Kentucky and Tennessee, averaging 9.25 inches over the basin of the Cumberland and somewhat less over the Tennessee basin. The result was the greatest flood of record in the Cumberland, a near-great flood in the Tennessee and Green Rivers and a decided rise in the Ohio with stages from 4 to 6 feet above the flood stages below the mouth of the Green River, the crest passing Cairo, Ill., on January 7, 1927.

Heavy rains also fell during the last two weeks of December over Mississippi and Arkansas but not over Louisiana, so that with only moderate support below Cairo from the White and Ouichita Rivers the flood finally passed New Orleans between January 24 and 27 without having exceeded the actual flood stages below Arkansas City, Ark., except, and only slightly, at Vicksburg, Miss.

January, 1927.—After the end of December there were no rains of much consequence until the third and fourth weeks of January, when there was a moderate to heavy fall over the Ohio Valley, the rains being accompanied by high temperatures that brought out water from the accumulated snow. At Pittsburgh, Pa., there was a flood crest of 29.7 feet on January 23, and at Cincinnati, Ohio, one of 59.1 on January 25. This flood received considerable support from the northern tributaries, but not so much from the southern ones, and the crest of 48.9 feet at Cairo on February 6 and 7 was exactly the same as that of January 7, while the crest of 44.2 feet at Paducah, Ky., was 2.6 feet lower than that of January 6.

Below Cairo there was considerable support received from the Arkansas, lower Red and Ouichita River, although without heavy February rains, and the crests in the main streams, except at New Orleans, were from 3 to 4 feet higher than during the January flood. At New Orleans on March 1 the crest was 18.8 feet, or 1.8 feet above flood stage. This flood crest required 38 days to travel from Pittsburgh to New Orleans, while the January crest required but 29 days. The season was advancing and between the two rises there was sufficient rainfall to hold the water at the comparatively high stages that are normal to the winter season in the lower Mississippi.

February, 1927.—Heavy rains fell over the Ohio and Red Basins during the week February 12–19. Over the Ohio Basin there was sufficient rise to bring the river at Cairo to a crest of 41.7 feet on March 5–6, from a low point of 38 feet on February 25.

Up to about March 15 there had been no high-water in the Missouri Basin, but little in the Mississippi above the mouth of the Ohio except in the Illinois and little, if any, more in the Arkansas Basin, while the Ohio between crests was holding at quite high stages, as was also the Yazoo, Ouichita, and Red, including the Atchafalaya, which at Mellville, La., had not been below 35 feet since January 19.

March, 1927.—During the last half of March rain much in excess of normal fell over the Mississippi Basin between the mouth of the Des Moines and the mouth of the Ohio, and during the last week over the Missouri Basin below Omaha, especially over the Kansas and Osage sub-basins. There was also a 14-day period of heavy rains over the Ohio Basin from March 12–25, heaviest over western Kentucky, western Tennessee, southern Indiana and Illinois; a seven-day period, March 12–18, over the lower Mississippi Basin, and moderate rains during the last half of the month over the Arkansas and Red Basins. The rivers were too high to be materially influenced by the rains of March 12–18, but those of the following week supplied the necessary stimulus and a general rise set in below the mouth of the Missouri. The Osage River was also in flood for a few days of the fourth week of the month Owing to irregular rainfall distribution the rise in the Ohio was likewise irregular above the mouth of the Green, but the last named and the lower Tennessee were both in flood and flood stages were once more passed below the mouth of the Green, the crests occurring nearly at the same time throughout this reach of the river.

At Cairo the crest stage of 52.8 feet on March 25 apparently received some assistance from the upper Mississippi as St. Louis reported a crest of 27.3 feet on March 21–22. This rise did not extend down the Mississippi much below Helena, Ark., where there was a crest of 51 feet on April 1–2; nevertheless, from the mouth of the Arkansas southward the river had been rising steadily, beginning with March 11 at Arkansas City and the rise from above was too small to affect it other than perhaps to increase the rate of rise somewhat and to prolong the flood wave.

April, 1927.—The month of April showed a general excess of rain over the entire drainage area, the major portion occurring during the first three weeks. Over the upper Mississippi Basin the excess was not large, but over the Missouri it was quite pronounced, especially during the week of April 9–15. Below the mouth of the Ohio the rains were heaviest during the 14 days, April 9–22, with very heavy falls over the Arkansas Basin. Over the Red Basin the heaviest fall occurred during the week April 9–15 and a week later over the lower Mississippi Basin. As these rains fell it became apparent that the real flood was yet to come and that it would certainly prove to be the greatest of all floods from Cairo southward. While the Ohio above the mouth of the Green did not again reach flood stages, there was a decided rise, the Green and Wabash Rivers were well above flood stages, the upper Mississippi below the mouth of the Des Moines was in moderate flood, with another and greater one to follow; the Missouri from Kansas City east was high, the St. Francis, Black, and White were in pronounced flood, and the Arkansas finally in great flood, the greatest since 1833. Farther down and a little later the Ouachita, Black, and lower Red Rivers were well above flood stage and still rising at the end of April.

TABLE 3.—*Precipitation by weeks, from December 18, 1926, to April 29, 1927*

Station	River	Dec. 18-24	Dec. 25-31	Jan. 1-7	Jan. 8-14	Jan. 15-21	Jan. 22-28	Jan. 29-Feb. 4	Feb. 5-11	Feb. 12-18	Feb 19-25	Feb. 26-Mar. 4	Mar. 5-11	Mar. 12-18	Mar. 19-25	Mar. 26-Apr 1	Apr. 2-8	Apr. 9-15	Apr. 16-22	Apr. 23-29	Total
OHIO RIVER DRAINAGE BASIN																					
Warren, Pa	Allegheny	0.14	1.01	0.61	0.09	0.59	0.32	0.48	0.26	1.08	1.14	0.74	0.60	0.47	2.32	0.37	1.86	0.60	0.80	1.46	14.34
Martin, Pa	Monongahela	0.74	1.62	0.42	0.25	1.45	1.58	0.65	0.46	0.93	2.52	0.39	0.48	0.64	1.88	0.61	0.61	0.83	0.26	0.60	16.92
Pittsburgh, Pa	Ohio	0.36	1.16	0.75	0.23	1.29	0.88	0.46	0.71	0.88	1.95	0.39	0.36	0.46	2.15	0.67	0.96	0.60	0.58	0.31	15.15
Parkersburg, W. Va	do	0.90	1.19	0.16	0.41	1.77	1.06	0.70	0.79	1.15	0.97	0.34	0.50	0.96	1.61	1.07	0.21	0.97	0.61	0.49	15.86
Zanesville, Ohio	Muskingum	0.44	1.39	0.10	0.35	1.81	1.15	0.90	0.26	0.99	0.81	0.18	0.27	1.32	1.66	1.11	0.30	0.99	0.20	0.73	14.96
Hinton, W. Va	Kanawha-New	2.43	2.17	0.43	0.49	0.06	0.25	0.62	0.96	1.02	3.11	0.37	0.62	0.42	0.28	1.61	1.01	2.06	1.30	0.28	19.51
Charleston, W. Va	do	2.56	1.38	0.18	0.61	1.16	1.24	1.00	1.27	0.53	2.27	0.34	0.90	0.54	0.64	1.36	0.87	1.80	2.04	0.40	21.09
Point Pleasant, W. Va	Ohio	1.68	1.63	0.08	0.60	2.18	2.21	0.78	0.67	0.99	1.64	0.30	1.20	1.12	1.15	0.92	0.55	1.46	0.91	0.78	20.85
Columbus, Ohio	Scioto	0.59	1.37	0.05	0.40	1.90	1.16	0.66	0.27	0.57	0.40	0.16	0.11	1.63	2.21	0.74	0.83	0.66	0.26	0.88	14.85
Chillicothe, Ohio	do	0.85	1.34	0.07	0.60	1.55	1.32	0.67	1.03	1.10	0.86	0.20	0.27	2.06	2.12	1.36	0.56	1.23	0.48	0.74	18.41
Portsmouth, Ohio	Ohio	1.42	1.49	0.02	0.67	2.63	2.10	0.54	0.91	0.87	1.56	0.16	0.36	0.92	0.78	1.28	0.43	1.30	1.27	0.17	18.88
Cincinnati, Ohio	do	0.69	1.29	T.	0.38	2.53	1.20	0.60	0.87	0.51	0.47	0.05	0.19	1.58	1.17	1.01	0.33	0.65	1.00	0.46	14.98
Dayton, Ohio	Miami	0.66	1.15	0.03	0.54	2.26	1.02	[illegible]	0.45	0.53	0.23	0.22	0.15	1.15	2.73	1.13	1.11	1.16	0.69	0.96	16.70
Madison, Ind	Ohio	1.37	1.41	0.00	0.62	3.19	1.57	[illegible]	0.20	0.22	0.74	0.15	0.46	2.67	2.21	1.08	0.78	0.75	0.80	0.02	18.59
Frankfort, Ky	Kentucky	2.18	1.55	T.	0.34	3.11	3.46	0.86	0.14	1.31	1.15	0.22	0.86	1.31	1.73	1.72	0.63	1.24	1.00	0.00	22.81
Louisville, Ky	Ohio	1.81	1.47	T.	0.51	3.09	3.74	0.33	0.12	0.53	1.32	0.36	0.75	2.61	2.04	1.55	0.63	0.88	1.16	0.00	22.90
Bowling Green, Ky	Barren	5.77	2.38	0.14	0.51	3.79	2.53	0.63	0.24	1.40	0.73	0.67	1.26	2.95	3.00	0.87	1.87	1.35	0.78	0.00	30.87
Woodbury, Ky	Green	4.43	1.93	T.	0.53	3.42	2.49	0.88	0.25	1.68	0.38	0.57	0.93	2.93	2.62	1.09	1.44	1.19	1.41	0.00	28.17
Evansville, Ind	Ohio	1.51	0.76	T.	0.51	2.98	2.45	0.21	0.03	0.21	0.46	0.27	0.67	3.54	1.70	2.05	0.64	2.68	1.39	0.00	22.06
Indianapolis, Ind	White (W. Fork)	0.45	0.91	T.	1.19	1.50	0.41	0.05	0.73	1.12	0.28	0.23	0.44	2.08	3.25	1.02	1.63	1.13	1.35	0.40	18.17
Elliston, Ind	do	0.44	0.66	T.	0.78	2.37	0.94	0.21	0.15	0.52	0.36	0.07	0.58	1.01	1.69	1.10	2.36	0.37	0.92	0.00	15.43
Terre Haute, Ind	Wabash	0.66	0.62	T.	1.65	0.83	0.48	0.04	0.43	0.76	0.60	0.03	0.51	1.66	4.27	1.38	0.51	1.14	1.19	0.11	16.87
Mount Carmel, Ill	do	1.07	0.70	0.00	0.95	2.41	1.63	0.67	0.15	0.42	0.20	0.20	0.37	2.96	1.12	1.62	2.17	2.34	1.54	0.04	20.56
Burnside, Ky	Cumberland	5.36	3.48	T.	0.44	0.92	0.92	1.35	0.67	1.06	1.47	0.55	1.68	0.74	0.99	1.20	0.83	1.71	1.55	0.32	25.24
Nashville, Tenn	do	7.03	3.35	T.	0.23	1.26	0.96	1.30	0.82	2.35	0.60	0.74	2.09	3.61	2.09	1.16	0.58	3.35	2.64	T.	34.16
Chattanooga, Tenn	Tennessee	2.42	4.69	0.00	0.24	0.56	0.34	0.62	0.78	1.93	1.33	1.70	2.90	1.50	0.47	2.34	0.86	5.13	0.67	0.00	28.48
Decatur, Ala	do	2.60	5.55	0.00	0.30	1.09	0.77	0.64	0.75	2.26	0.40	0.88	2.40	1.77	0.35	0.88	0.29	2.12	0.89	0.00	23.94
Johnsonville, Tenn	do	8.92	2.86	0.00	0.32	2.40	1.50	1.22	0.90	1.76	0.52	0.50	3.12	4.98	2.66	2.09	0.66	5.82	3.00	0.00	43.23
Cairo, Ill	Ohio	2.25	1.11	T.	0.39	3.48	4.16	0.61	0.41	0.34	0.13	0.41	0.51	2.94	1.25	2.96	2.56	3.14	2.64	T.	29.29
UPPER MISSISSIPPI RIVER DRAINAGE BASIN																					
Fort Ripley, Minn	Mississippi	0.07	0.00	0.00	0.05	0.25	0.00	T.	0.15	0.23	0.15	0.00	0.00	0.40	0.11	0.30	1.15	0.51	1.43	0.00	4.80
Mankato, Minn	Minnesota	0.46	0.00	0.04	0.07	0.30	0.00	0.00	0.53	0.28	0.00	T	0.28	0.48	1.05	0.09	0.94	1.58	1.22	0.29	7.61
St. Paul, Minn	Mississippi	0.70	T.	T.	0.30	0.25	0.11	0.02	0.15	0.13	T.	T.	0.22	1.03	0.40	0.42	0.68	0.17	0.90	0.41	5.89
Rhinelander, Wis	Wisconsin	0.12	0.06	0.00	0.16	0.27	0.24	0.22	0.27	T.	0.00	0.12	0.36	0.84	0.41	0.27	0.41	0.00	0.91	0.45	5.11
Park Rapids, Minn	Mississippi	0.12	0.02	0.00	0.23	0.35	T.	0.46	0.50	0.13	0.26	T.	T.	0.34	0.30	0.40	1.00	0.26	0.45	0.20	5.02
Medford, Wis	Black	0.17	0.10	0.00	0.25	0.20	0.21	T.	0.10	0.08	0.00	0.14	0.15	1.35	0.44	0.40	0.60	0.15	0.21	0.43	4.98
Wisconsin Rapids, Wis	Wisconsin	-	-	-	-	-	-	-	-	-	-	0.00	T.	1.07	0.37	1.10	0.35	T.	1.13	0.47	4.49
Portage, Wis	do	0.13	0.06	0.07	0.31	0.25	0.13	0.00	0.05	0.02	0.00	T.	0.08	1.14	0.31	0.33	0.33	0.47	1.77	0.62	6.07
Dubuque, Iowa	Mississippi	0.03	T.	0.02	0.29	0.09	0.02	0.54	0.02	0.25	0.01	0.01	1.17	0.29	0.67	0.75	0.67	1.14	0.84	0.60	7.41
Davenport, Iowa	do	0.02	T.	0.05	0.53	0.19	T.	T.	1.68	0.50	0.18	T.	0.21	1.74	0.77	0.85	0.88	1.18	1.59	0.55	10.92
Des Moines, Iowa	Des Moines	0.35	0.03	T.	0.18	0.04	0.02	T.	0.56	0.41	0.22	0.05	0.37	0.64	0.64	2.51	0.64	2.00	1.03	0.44	10.13
Hannibal, Mo	Mississippi	0.15	0.00	T.	1.13	0.01	0.42	T.	0.58	0.66	0.18	0.11	0.59	1.72	3.11	1.49	0.32	2.46	0.98	0.04	13.95
Peoria, Ill	Illinois	0.27	0.00	0.03	1.42	0.11	0.19	0.01	1.05	0.61	1.19	T.	0.59	1.63	1.68	0.86	0.37	1.51	2.23	0.53	14.28
Beardstown, Ill	do	0.37	0.00	0.02	0.88	0.00	0.18	0.00	0.53	0.45	0.48	0.06	0.46	1.90	3.50	1.22	1.39	2.97	1.25	0.03	15.09
St. Louis, Mo	Mississippi	0.60	0.15	T.	2.42	0.64	0.60	T.	0.29	0.22	0.05	0.30	0.28	0.94	2.45	3.70	0.87	3.88	0.96	T.	18.35
Cape Girardeau, Mo	do	2.04	0.98	0.00	0.42	2.78	3.93	0.52	0.06	0.44	0.03	0.42	0.62	3.78	1.16	2.68	1.78	3.40	2.07	0.02	27.13
MISSOURI RIVER DRAINAGE BASIN																					
Helena, Mont	Missouri	T.	T.	0.03	0.29	0.43	0.04	0.05	0.03	0.14	0.25	0.02	0.07	0.37	0.01	0.30	0.02	0.06	0.15	0.08	2.29
Sheridan, Wyo	Tongue	0.13	0.04	T.	0.26	0.40	0.04	0.00	0.10	0.19	0.05	0.06	0.40	0.27	0.16	0.16	0.12	3.04	1.13	0.02	6.57
Miles City, Mont	Yellowstone	0.36	0.00	0.02	0.08	0.50	0.01	T.	0.05	0.05	T.	0.12	0.00	0.13	0.03	0.03	0.10	1.74	0.13	0.35	3.70
Havre, Mont	Milk	0.21	0.00	0.24	0.01	0.31	0.00	0.17	0.23	0.13	T.	0.08	T.	0.19	0.15	0.17	0.38	0.45	0.40	0.03	3.05
Williston, N. Dak	Missouri	0.43	0.01	0.33	0.07	0.16	T.	0.06	0.26	0.10	0.04	T.	0.13	0.01	0.10	0.14	0.02	0.47	0.46	0.11	2.90
Bismark, N. Dak	do	T.	0.00	T.	0.02	0.16	T.	0.06	0.08	0.07	0.04	T.	0.44	T.	0.29	0.20	0.39	0.65	0.30	T.	2.70
Pierre, S. Dak	do	0.00	0.00	0.00	0.03	0.23	0.03	0.01	T.	0.03	0.06	0.02	0.01	0.29	0.11	0.38	0.69	2.27	0.20	T.	4.36
Valentine, Nebr	Niobrara	0.00	T.	0.01	0.27	0.24	0.03	0.00	T.	0.09	0.18	0.39	0.92	0.27	0.45	1.14	0.41	2.71	0.24	0.04	7.39
Yankton, S. Dak	Missouri	0.03	T.	0.00	0.07	0.01	T.	0.43	0.04	0.41	0.01	0.05	1.13	0.44	0.60	1.50	0.84	4.04	0.60	T.	10.20
Cheyenne, Wyo	South Platte	0.04	0.00	0.00	0.10	0.05	T.	T.	0.35	0.01	0.05	0.73	0.34	0.19	0.59	0.76	0.02	1.87	0.19	0.17	5.46
Denver, Colo	do	0.31	0.00	0.00	0.14	0.04	0.00	0.00	0.10	0.01	0.00	0.24	0.85	0.38	0.50	0.44	T.	1.29	0.04	0.20	4.63
Fort Morgan, Colo	do	0.10	0.00	0.00	0.00	0.01	T.	0.00	0.01	T.	0.00	0.46	0.28	0.07	0.22	0.33	0.00	1.33	0.39	0.34	3.54
North Platte, Nebr	Platte	T.	0.00	0.00	0.04	0.06	T.	0.01	0.01	0.02	0.22	0.25	0.39	0.17	0.50	0.17	T.	2.96	0.20	0.06	5.06
Omaha, Nebr	Missouri	0.56	0.10	T.	0.09	0.02	T.	0.21	0.05	0.58	T.	0.25	0.42	0.14	0.24	1.13	0.15	1.19	0.43	0.03	5.59
Beatrice, Nebr	Blue	0.24	0.00	0.00	0.06	T.	0.00	0.25	0.00	0.70	0.00	0.55	0.75	T.	0.15	1.77	0.50	1.70	1.03	3.00	10.70
Concordia, Kans	Republican	0.24	0.00	0.00	0.10	0.0[illegible]	0.03	0.15	0.08	0.98	0.00	0.25	0.79	T.	0.06	1.40	0.14	2.15	0.74	0.76	7.89
Beloit, Kans	Solomon	0.14	0.00	0.60	0.06	0.03	T.	0.09	0.06	0.71	0.00	0.37	0.19	0.73	0.07	0.80	0.13	1.15	1.12	0.44	6.09
Ellsworth, Kans	Smoky Hill	0.38	0.00	0.00	0.10	T.	0.20	0.40	0.30	1.00	0.00	0.25	1.63	0.00	T.	0.41	1.02	0.93	0.77	0.93	8.32
Abilene, Kans	do	0.68	0.00	0.00	0.21	T.	0.02	0.18	0.09	0.52	0.00	0.16	0.40	T.	0.05	1.20	0.30	1.91	1.13	0.10	6.95
Manhattan, Kans	Kansas	0.29	0.00	0.00	0.23	T.	0.10	0.52	0.07	0.80	0.00	0.20	0.73	T.	0.04	3.14	0.52	2.53	1.83	0.37	11.37
Alton, Kans	Solomon	T.	0.00	0.00	0.10	T.	T.	0.15	0.15	0.75	0.00	0.70	1.95	0.03	0.20	0.75	0.05	1.41	0.91	0.57	7.72
Topeka, Kans	Kansas	0.18	0.00	0.00	0.47	0.05	0.21	0.01	0.27	0.45	T.	0.23	0.50	1.40	0.32	3.06	0.36	2.04	2.16	0.87	12.08
Kansas City, Mo	Missouri	0.13	T.	0.00	0.92	0.08	0.29	T.	0.17	0.63	T.	0.26	0.77	0.48	1.03	2.19	0.41	2.51	2.91	0.17	12.95
Boonville, Mo	do	0.49	0.00	0.00	0.85	0.02	0.00	0.00	0.42	0.10	T.	0.20	0.62	0.40	3.83	2.80	0.84	3.67	0.40	0.25	15.55
Osceola, Mo	Osage	1.21	0.00	0.00	1.21	0.08	1.06	0.00	1.02	0.10	0.00	0.75	0.40	0.49	3.43	3.45	1.19	4.83	1.28	0.00	20.52
Warsaw, Mo	do	0.81	0.00	0.00	1.11	0.12	0.96	0.00	0.44	0.10	0.00	0.24	0.74	1.00	4.30	3.44	1.26	3.96	0.54	T.	19.02
Hermann, Mo	Missouri	0.98	0.01	0.00	1.35	0.06	0.50	0.00	0.08	0.39	0.00	0.16	0.57	1.34	4.20	3.25	0.52	3.97	0.93	0.00	18.40

T. indicates trace.

TABLE 3.—*Precipitation by weeks, from December 18, 1926, to April 29, 1927*—Continued

ARKANSAS-WHITE RIVERS DRAINAGE BASIN

Station	River	Dec. 18-24	Dec. 25-31	Jan. 1-7	Jan. 8-14	Jan. 15-21	Jan. 22-28	Jan. 29-Feb. 4	Feb. 5-11	Feb. 12-18	Feb. 19-25	Feb. 26-Mar. 4	Mar. 5-11	Mar. 12-18	Mar. 19-25	Mar. 26-Apr. 1	Apr. 2-8	Apr. 9-15	Apr. 16-22	Apr. 23-29	Total
Garfield, Colo	Little Ark	0.35	0.00	0.00	0.14	0.11	0.22	0.32	0.19	2.74	0.92	1.58	1.07	0.66	0.90	T.	0.00	0.64	0.28	T.	10.12
Pueblo, Colo	Arkansas	0.24	0.00	0.00	0.15	0.08	0.00	0.00	0.37	0.01	0.00	0.53	0.56	0.43	0.18	0.00	T.	0.01	T.	0.06	2.62
Trinidad, Colo	Purgatoire	0.33	0.00	0.00	0.10	0.00	0.00	0.00	0.01	0.09	0.00	0.00	1.29	0.00	0.15	0.08	0.00	0.70	0.28	0.00	3.03
Syracuse, Kans	Arkansas	0.25	0.00	0.00	T.	0.12	T.	0.00	0.00	0.00	0.00	0.34	0.35	0.05	0.20	0.20	0.05	0.75	1.15	T.	3.46
Ashland, Kans	Cimarron	0.22	0.00	0.00	0.00	T.	0.16	T.	0.05	0.27	0.00	0.75	0.88	0.00	T.	0.69	0.14	0.62	0.93	0.07	4.78
Emporia, Kans	Neosho	0.25	0.00	0.00	0.39	T.	0.27	0.20	0.00	0.25	0.00	0.18	1.52	0.00	0.90	2.36	1.03	1.94	2.90	0.55	12.74
Springer, N. Mex	Canadian	0.27	0.00	0.00	0.00	0.00	0.00	0.00	T.	0.00	0.60	0.13	0.21	0.00	0.04	0.00	0.00	0.44	0.10	0.00	1.19
Dalhart, Tex	do	0.14	0.00	0.00	T.	T.	0.00	0.10	0.00	0.00	0.00	0.23	0.20	0.00	0.00	0.09	0.00	0.88	0.02	0.00	1.66
Oswego, Kans	Neosho	0.10	0.00	0.00	0.92	0.00	1.02	0.10	0.32	0.07	0.00	0.35	0.60	0.36	1.23	3.60	0.90	5.70	1.36	0.60	17.23
Woodward, Okla	North Canadian	0.26	0.00	0.00	0.01	0.01	0.10	0.02	0.03	0.62	0.01	0.51	0.01	0.45	0.02	0.75	0.45	0.36	1.21	0.02	4.84
Oklahoma City, Okla	do	1.33	T.	0.00	0.86	T.	0.75	T.	0.20	0.24	0.00	0.66	0.54	0.02	0.13	1.51	1.09	2.93	0.03	0.54	10.83
Calvin, Okla	Canadian	1.75	0.02	0.00	0.96	0.49	0.47	0.16	0.70	0.00	0.00	1.05	0.10	1.94	0.80	0.43	1.70	2.35	2.10	0.46	15.48
Dodge City, Kans	Arkansas	0.01	0.00	0.00	T.	0.01	0.01	0.01	0.10	0.63	0.03	0.44	1.16	0.29	0.04	0.24	2.62	0.77	0.67	0.31	7.34
Wichita, Kans	do	0.33	0.00	0.00	0.30	0.02	0.23	T.	0.15	0.56	0.01	0.40	0.27	0.28	0.27	2.98	1.14	1.63	1.78	0.25	10.60
Okay, Okla	Verdigris	1.22	0.00	0.00	2.00	0.50	1.67	0.95	0.41	0.23	0.00	1.09	0.03	1.28	0.68	0.90	0.70	6.33	2.28	0.04	20.31
Fort Smith, Ark	Arkansas	1.84	0.15	0.00	0.79	0.45	3.36	0.14	0.41	0.53	0.03	1.04	0.16	1.73	0.29	0.75	0.25	6.02	3.33	0.07	21.34
Ozark Beach, Mo	White	0.88	0.12	0.00	1.35	0.49	1.30	0.28	0.15	0.20	0.03	0.00	0.37	1.81	0.81	0.93	0.78	6.15	3.70	0.06	19.41
Ozark, Ark	Arkansas	2.12	0.57	0.00	0.77	1.91	5.00	0.00	0.58	0.52	0.00	0.63	0.00	2.87	0.36	0.65	0.68	6.97	6.28	0.06	29.97
Subiaco, Ark	do	2.50	1.04	0.00	0.70	1.70	4.09	0.08	0.96	0.25	0.11	1.51	0.66	4.67	1.15	0.57	0.65	9.79	6.55	0.01	36.99
Lurton, Ark	White	2.52	0.84	0.00	1.27	2.41	4.79	0.27	0.51	0.89	0.00	0.60	1.39	2.35	0.51	2.26	0.71	10.26	6.17	0.11	37.86
Danville, Ark	Petit Jean	2.75	1.10	0.00	0.50	1.90	5.22	T.	1.17	0.12	T.	1.15	0.47	2.26	T.	1.00	0.30	15.65	5.93	T.	39.52
Morrillton, Ark	Arkansas	3.62	1.60	0.00	0.51	1.84	2.39	0.00	0.81	0.10	0.00	0.50	1.42	0.89	0.52	1.12	0.30	7.30	3.36	0.00	26.28
Little Rock, Ark	do	6.63	1.82	0.00	0.43	1.43	2.56	0.17	1.33	0.58	0.09	1.13	3.69	0.68	1.10	1.23	0.64	5.26	8.90	0.00	37.67
Pine Bluff, Ark	do	6.25	1.31	0.00	0.40	2.96	1.88	0.21	1.16	0.43	0.01	1.45	2.55	1.11	0.83	2.67	0.37	5.21	4.39	0.00	33.19
Poplar Bluff, Mo	Black	2.24	1.28	0.00	0.59	2.51	6.68	0.86	0.41	0.49	0.06	0.36	0.41	3.85	1.01	1.99	2.96	7.82	1.32	0.06	34.90
Corning, Ark	White	3.18	1.52	0.00	0.45	6.17	2.86	0.40	0.10	1.05	0.00	0.32	0.25	4.02	1.09	1.13	1.65	7.35	0.82	0.00	32.36
Black Rock, Ark	Black	4.29	1.18	0.00	0.36	3.66	2.96	0.58	0.31	1.04	0.10	0.43	0.33	4.48	1.51	1.71	2.56	7.15	1.41	T.	34.06
Gilbert, Ark	White	1.58	0.71	0.00	0.45	0.67	6.37	0.56	0.30	0.58	0.02	0.88	0.34	1.56	0.36	1.69	1.43	7.30	5.20	0.10	30.30
Batesville, Ark	do	5.15	1.57	0.00	0.60	3.72	4.45	0.45	0.34	1.60	0.02	0.76	0.77	4.55	1.87	0.93	1.46	7.23	2.67	0.12	38.26
Newport, Ark	do	3.45	1.47	0.00	0.43	2.56	2.07	0.37	0.39	1.12	0.06	0.41	0.89	2.98	1.57	0.90	0.68	6.92	2.36	0.05	28.68
Arlberg, Ark	do	3.57	0.86	0.00	0.52	3.27	5.89	0.20	0.40	0.80	0.00	0.68	1.90	3.97	0.37	1.05	0.88	9.70	3.50	0.30	37.86
Judsonia, Ark	Little Red	4.96	1.19	0.07	0.34	1.90	2.33	T.	0.89	0.62	0.36	0.77	2.01	0.64	1.66	1.01	0.48	9.63	2.59	0.27	31.72
Patterson, Ark	White	6.31	2.02	0.00	0.12	1.75	2.87	0.72	1.68	0.70	0.06	0.16	2.28	2.30	0.84	1.39	0.38	7.78	3.55	0.08	34.99
Clarendon, Ark	White	6.28	1.09	0.00	0.34	1.08	2.05	0.36	1.60	2.70	0.20	1.30	4.56	3.30	2.63	0.59	0.36	4.78	4.40	0.18	37.80

RED RIVER DRAINAGE BASIN

Station	River	Dec. 18-24	Dec. 25-31	Jan. 1-7	Jan. 8-14	Jan. 15-21	Jan. 22-28	Jan. 29-Feb. 4	Feb. 5-11	Feb. 12-18	Feb. 19-25	Feb. 26-Mar. 4	Mar. 5-11	Mar. 12-18	Mar. 19-25	Mar. 26-Apr. 1	Apr. 2-8	Apr. 9-15	Apr. 16-22	Apr. 23-29	Total
Denison, Tex	Red	3.34	0.87	0.00	1.00	1.00	2.45	0.00	1.17	0.00	0.00	2.80	1.40	0.30	0.15	0.00	0.72	3.06	4.25	0.70	24.10
Arthur City, Tex	do	3.08	T.	0.00	0.13	0.18	2.99	0.00	1.77	0.14	0.00	2.79	1.75	0.74	0.20	0.39	0.98	3.96	1.40	0.52	21.02
Springbank, Ark	do	3.30	1.55	0.00	0.53	2.97	0.31	0.04	1.36	1.03	0.00	2.85	2.14	0.60	1.35	0.35	2.62	4.14	3.08	0.23	28.54
Fulton, Ark	do	4.87	1.20	0.00	0.48	2.07	0.78	0.00	2.49	0.33	0.00	3.93	2.31	1.03	1.20	0.60	4.23	6.63	1.63	0.28	34.00
Ringo Crossing, Tex	Sulphur	5.81	1.16	0.00	0.64	0.87	1.08	0.03	1.95	0.15	0.00	2.30	2.41	1.20	0.49	0.27	2.63	3.10	1.41	0.42	25.92
Jefferson, Tex	Cypress	6.54	0.47	0.00	1.24	1.23	0.41	0.00	3.03	0.49	0.09	0.42	2.10	0.59	2.05	0.00	2.18	3.14	2.22	0.26	26.46
Shreveport, La	Red	5.35	1.71	0.00	0.64	0.65	0.11	0.06	0.35	1.82	0.05	0.72	1.92	1.15	1.43	0.52	4.65	2.44	0.54	0.07	24.18
Alexandria, La	do	1.06	5.91	0.00	0.95	1.17	0.25	T.	T.	5.65	0.50	0.45	1.95	4.63	2.25	T.	2.83	6.40	1.92	0.00	35.92
Arkadelphia, Ark	Ouachita	5.56	1.47	0.00	0.45	2.39	2.56	0.08	1.08	0.40	0.00	2.56	2.90	0.48	0.70	1.10	0.23	5.93	5.45	0.11	33.46
Camden, Ark	do	4.31	1.29	0.00	0.44	2.89	0.52	0.13	1.93	0.94	0.00	2.03	1.88	0.97	0.96	1.51	1.34	4.45	2.48	0.13	27.70
Monroe, La	do	4.39	6.98	0.00	0.79	2.92	0.53	0.09	1.04	4.35	T.	1.62	4.52	4.11	1.71	0.74	2.07	2.60	6.27	0.00	44.72
Melville, La	Atchafalaya	0.20	3.31	0.00	1.00	0.35	0.00	0.00	0.60	9.50	0.25	1.70	1.00	1.20	2.00	0.25	0.06	3.00	0.25	0.00	24.67

LOWER MISSISSIPPI RIVER DRAINAGE BASIN

Station	River	Dec. 18-24	Dec. 25-31	Jan. 1-7	Jan. 8-14	Jan. 15-21	Jan. 22-28	Jan. 29-Feb. 4	Feb. 5-11	Feb. 12-18	Feb. 19-25	Feb. 26-Mar. 4	Mar. 5-11	Mar. 12-18	Mar. 19-25	Mar. 26-Apr. 1	Apr. 2-8	Apr. 9-15	Apr. 16-22	Apr. 23-29	Total
New Madrid, Mo	Mississippi	3.36	1.79	0.00	0.49	4.93	2.29	0.47	0.30	2.38	0.20	0.42	0.64	4.19	1.90	2.01	1.52	4.92	4.14	T.	35.96
Memphis, Tenn	do	6.44	1.68	0.00	0.30	1.52	1.54	0.44	1.22	0.93	0.09	0.54	3.32	6.18	2.28	0.96	0.11	3.22	9.44	0.01	40.22
Marked Tree, Ark	St. Francis	5.38	1.21	0.00	0.39	2.74	2.16	0.67	1.08	0.86	0.05	0.56	2.22	3.55	1.54	1.04	0.64	4.45	8.23	T.	36.77
Helena, Ark	Mississippi	4.76	2.36	0.00	0.36	1.20	1.96	0.70	0.58	0.86	0.16	1.14	2.20	7.92	1.32	1.04	0.96	2.96	6.48	0.24	37.20
Arkansas City, Ark	do	3.82	4.84	0.00	0.12	1.23	0.46	0.22	1.08	2.11	0.02	2.52	1.67	3.98	1.11	2.74	0.55	4.29	5.01	0.00	35.77
Greenville, Miss	do	6.20	6.60	0.00	0.48	1.47	0.30	0.16	1.05	2.89	0.00	1.56	2.23	3.35	2.11	1.78	0.59	3.90	8.94	0.00	43.11
Yazoo City, Miss	Yazoo	3.24	6.35	0.00	0.13	5.24	0.17	0.02	0.40	5.71	0.00	0.84	2.79	3.46	1.50	1.64	1.25	3.49	0.88	0.00	37.11
Vicksburg, Miss	Mississippi	1.33	6.65	0.00	0.48	3.66	0.13	0.03	0.05	9.45	0.04	1.22	2.42	3.77	1.15	0.95	1.17	2.96	0.61	0.00	36.07
Natchez, Miss	do	0.53	4.40	0.00	0.92	0.45	0.00	T.	0.10	5.46	1.46	0.59	1.72	2.20	1.93	0.00	0.87	3.54	0.79	0.00	24.96
Baton Rouge, La	do	1.95	0.75	0.00	0.87	1.35	0.00	0.00	0.27	5.19	0.42	1.74	0.20	1.60	3.57	0.10	0.02	0.50	0.61	0.00	19.14
Donaldsonville, La	do	0.67	1.14	0.00	1.07	0.22	T.	0.21	0.02	3.44	0.15	2.00	0.61	1.51	4.46	T.	0.00	0.24	4.01	0.00	19.75
New Orleans, La	do	0.12	0.80	0.00	0.55	0.06	T.	0.01	0.44	6.64	1.01	4.17	0.26	1.29	4.32	T.	0.81	T.	14.13	0.00	34.61

T. indicates trace.

The resulting stages are given elsewhere in this report, see Table 2. The occurrence of crevasses in Arkansas, Mississippi, and Louisiana prevented still higher stages from the mouth of the Arkansas southward. The rise at New Orleans was brought to a conclusion on April 25 because of the dynamiting of the levee at Caernarvon, 14 miles below, and within the two weeks following the river fell 0.5 foot, after which there was a final crest of 20.7 feet on May 15. This latter crest began at Vicksburg on May 4, when the flow of water from the Mounds Landing, Miss., crevasse through the Yazoo Basin was at its peak, and was simply a delayed rise that would have been still greater had the levees above remained intact.

During the months of May, June, and July there was a very slow but general recession that was interrupted, however, by more heavy rains early in May over the Missouri and upper Mississippi Basins that again raised the Mississippi above the flood stage from Hannibal to Cairo and materially checked the fall below. There was a more decided rise in June with the Ohio as a further contributing factor, with the result that stages from 4 to 5 feet above the flood stage were experienced from Cairo, Ill., to Helena, Ark., and somewhat less from Vicksburg to Natchez, Miss. These latter rises, while not very great, were most unfortunate in that they reoverflowed much land from which the earlier flood had receded and on which crops had again been planted. The latest flood stage recorded was at Baton Rouge, La., where the river did not pass below the flood stage until July 14, while the last overflow water did not pass into the Gulf of Mexico until some time after August 1, 1927. This was over extreme southern Louisiana.

Table No. 4 shows the number of days the rivers were above flood stages during the flood of 1927.

TABLE 4.—*Number of days rivers were above flood stages during spring floods of 1927*

Station	River	Flood stage	Duration and dates		
			Number of days	Total days	Dates
Pittsburgh, Pa	Ohio	25	3	3	Jan. 22-24.
Zanesville, Ohio	Muskingum	25	2	2	Jan. 23-24.
Cincinnati, Ohio	Ohio	52	7	7	Jan. 24-30.
Frankfort, Ky	Kentucky	31	3	3	Jan. 22-24.
Louisville, Ky	Ohio	28	9	9	Jan. 24-Feb. 1.
Lock No. 2, Rumsey, Ky	Green	34	22		Jan. 22-Feb. 12.
Do	do		25	47	Mar. 13-Apr. 6.
Evansville, Ky	Ohio	35	18		Jan. 23-Feb. 9.
Do	do		8		Feb. 26-Mar. 5.
Do	do		18	44	Mar. 20-Apr. 6.
Mount Carmel, Ill	Wabash	16	27		Jan. 23-Feb. 18.
Do	do		41		Mar. 19-Apr. 28.
Do	do		22	90	May 22-June 12.
Clarksville, Tenn	Cumberland	46	19		Dec. 22, 1926-Jan. 9, 1927.
Do	do		5	24	Mar. 13-17.
Johnsonville, Tenn	Tennessee	31	17		Dec. 26, 1926-Jan. 11, 1927.
Do	do		8		Mar. 14-21.
Do	do		4	29	Apr. 15-18.
Paducah, Ky	Ohio	43	11		Jan. 1-11.
Do	do		6		Feb. 3-8.
Do	do		8		Mar. 20-27.
Do	do		12	37	Apr. 13-24.
Cairo, Ill	do	45	12		Jan. 1-12.
Do	do		13		Feb. 1-13.
Do	do		50		Mar. 17-May 5.
Do	do		13	88	June 2-14.
Keokuk, Iowa	Mississippi	14	5	5	Apr. 20-24.

TABLE 4.—*Number of days rivers were above flood stages during spring floods of 1927*—Continued

Station	River	Flood stage	Duration and dates		
			Number of days	Total days	Dates
Hannibal, Mo	Mississippi	13	29		Mar. 31-Apr. 28.
Do	do		2		May 20-21.
Do	do		16	47	May 25-June 9.
Beardstown, Ill	Illinois	14	31		Dec. 1-31, 1926.
Do	do		155	186	Feb. 4-July 8.
Grafton, Ill	Mississippi	18	4		Mar. 21-24.
Do	do		33		Apr. 2-May 4.
Do	do		4		May 10-13.
Do	do		25	66	May 25-June 18.
Omaha, Nebr	Missouri	19	3	3	May 14-16.
Kansas City, Mo	do	22	4	4	Apr. 19-22.
Chillicothe, Mo	Grand	18	4		Apr. 2-5.
Do	do		15		Apr. 10-24.
Do	do		3	22	June 4-6.
Tuscumbia, Mo	Osage	25	8		Mar. 20-27.
Do	do		8		Apr. 1-8.
Do	do		19		Apr. 11-29.
Do	do		2	37	June 24-25.
Hermann, Mo	Missouri	21	17		Apr. 12-28.
Do	do		1		May 10.
Do	do		3	21	June 5-7.
St. Louis, Mo	Mississippi	30	4		Apr. 4-7.
Do	do		19		Apr. 13-May 1.
Do	do		1		May 11.
Do	do		8	32	June 4-11.
Cape Girardeau, Mo	do	30	7		Mar. 22-28.
Do	do		35		Apr. 2-May 6.
Do	do		6		May 10-15.
Do	do		26	74	May 26-June 20.
New Madrid, Mo	do	34	13		Jan. 1-13.
Do	do		16		Feb. 1-16.
Do	do		61		Mar. 17-May 16.
Do	do		18	108	June 1-18.
Memphis, Tenn	do	35	12		Jan. 5-16.
Do	do		16		Feb. 5-20.
Do	do		62		Mar. 19-May 19.
Do	do		17	107	June 6-22.
Marked Tree, Ark	St. Francis	17	20		Feb. 1-20.
Do	do		71	91	Apr. 9-June 18.
Helena, Ark	Mississippi	44	10		Jan. 9-18.
Do	do		18		Feb. 7-24.
Do	do		65		Mar. 20-May 23
Do	do		18	111	June 8-25.
Oswego, Kans	Neosho	17	3		Mar. 20-22.
Do	do		4		Apr. 2-5.
Do	do		19		Apr. 9-27.
Do	do		3	29	May 8-10.
Fort Smith, Ark	Arkansas	22	17	17	Apr. 12-28.
Little Rock, Ark	do	23	16	16	Apr. 15-30.
Pine Bluff, Ark	do	25	19	19	Apr. 15-May 3.
Black Rock, Ark	Black	14	25		Jan. 21-Feb. 14.
Do	do		104	129	Mar. 18-June 29.
Clarendon, Ark	White	30	14		Jan. 31-Feb. 13.
Do	do		27	41	Apr. 16-May 12.
Arkansas City, Ark	Mississippi	48	7		Jan. 14-20.
Do	do		24		Feb. 6-Mar. 1.
Do	do		50	81	Mar. 22-May 10.
Greeneville, Miss	do	42	21		Feb. 8-28.
Do	do		48	69	Mar. 24-May 10.
Greenwood, Miss	Yazoo	36	11	11	Dec. 31, 1926-Jan. 10, 1927.
Yazoo City, Miss	do	25	185	185	Jan. 9-July 12.
Vicksburg, Miss	Mississippi	45	10		Jan. 16-25.
Do	do		156	166	Feb. 6-July 11.
Natchez, Miss	do	46	149	149	Feb. 12-July 10.
Alexandria, La	Red	36	29	29	Apr. 20-May 18.
Camden, Ark	Ouachita	30	10		Dec. 24, 1926-Jan. 2, 1927.
Do	do		9		Jan. 25-Feb. 2.
Do	do		8		Mar. 10-17.
Do	do		15	42	Apr. 16-30.
Monroe, La	do	40	90	90	Mar. 20-June 17.
Baton Rouge, La	Mississippi	35	153	153	Feb. 12-July 14.
Donaldsonville, La	do	28	147	147	Feb. 12-July 8.
New Orleans, La	do	17	120	120	Feb. 13-June 12.
Melville, La	Atchafalaya	37	120	120	Feb. 14-June 13.
Morgan City, La	do	8	31	31	May 26-June 25.

ANALYSIS OF RAINFALL

In order to present the rainfall data for the 1927 floods with greater precision than is possible by the usual system of averages, recourse was had to a scheme previously described (1, loc. cit. pp. 8, 9). For convenience the description is reproduced below.

The rainfall for each drainage basin was computed according to a method suggested by Marvin, and is as follows: Monthly data for a large number of stations were charted and isohyetal lines carefully drawn. These lines were then traced upon sheets of cross-section paper, together with the outlines of the six drainage areas.

The isohyets divide the drainage basins into various irregular small subareas, over which the precipitation may be assumed to be uniform and of an amount represented by the mean between the two adjacent isohyetals. Therefore the number of squares in each subarea was counted. This number was then multiplied by the average precipitation for the subarea in question and the product divided by the sum of the counts for all the subareas, which latter, of course, is the number of squares in the whole drainage basin being studied. Finally, the sum of the quotients found in the above manner gives the depth of precipitation, which, spread uniformly over the whole basin, would represent the same amount of water as fell in the irregularly distributed precipitation. This procedure, while laborious, was well worth the time consumed, and it is thought to have accomplished a more accurate presentation of data than was possible otherwise.

The amount of squares in the subarea was limited always by the boundary lines of the watershed, except in the extreme upper Arkansas, Missouri, and Mississippi Valleys. In these territories the winter and spring precipitation is invariably small, mostly in the form of light snow, contributing practically nothing to flood conditions. The drainage basins were therefore cut off for these regions by an arbitrary straight line running from the headwaters of the Canadian northeastward through Omaha and a point about 150 miles east of St. Paul.

In MONTHLY WEATHER REVIEW SUPPLEMENT No. 22 (loc. cit.) the entire drainage area of 1,250,900 square miles was not used, the extreme upper Arkansas, the upper Missouri, and the extreme upper Mississippi Valleys having been eliminated for the reason that their precipitation in winter and spring, being small and mostly in the form of snow, usually contributed little or nothing to flood conditions. About 30 per cent of the total area was thus eliminated, but owing to the substantial amounts of precipitation over these upper areas in 1927 it became necessary to compute the depth of water over the entire area, and equally necessary for purposes of proper comparison to recompute on the same basis the data for 1882, 1903, 1912, 1913, and 1922. The results of the computations are as given in Table 5, and with them are also the departures from the normal values.

TABLE 5.—*Precipitation for six floods in terms of inches of water over entire drainage area, and normal departures for same*

[Departures plus when without sign]

Subarea	Drainage (square miles)	1882								1903							
		January		February		March		Total		January		February		March		Total	
		Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure
Upper Mississippi	187,850	0.17	−0.04	0.49	0.29	0.44	0.14	1.10	0.39	0.10	−0.11	0.24	0.04	0.33	0.03	0.67	−0.04
Missouri	528,850	0.20	−0.10	0.55	0.22	0.44	−0.06	1.19	0.06	0.23	−0.07	0.53	0.20	0.47	−0.02	1.23	0.11
Ohio	203,900	0.94	0.29	0.92	0.39	0.73	0.02	2.59	0.70	0.33	−0.32	0.86	0.33	0.59	−0.12	1.78	−0.11
Arkansas-White	186,000	0.24	0.03	0.47	0.25	0.31	−0.01	1.02	0.27	0.11	−0.10	0.50	0.28	0.27	−0.05	0.88	0.13
Red	90,000	0.35	0.17	0.29	0.12	0.20	−0.03	0.84	0.26	0.13	−0.05	0.41	0.24	0.26	0.03	0.80	0.22
Lower Mississippi	54,300	0.37	0.16	0.31	0.12	0.26	0.04	0.94	0.32	0.17	−0.04	0.33	0.14	0.25	0.03	0.75	0.13
Total	1,250,900	2.27	0.51	3.03	1.39	2.38	0.10	7.68	2.00	1.07	−0.69	2.87	1.23	2.17	−0.10	5.11	0.44

Subarea	Drainage (square miles)	1912								1913							
		February		March		April		Total		January		February		March		Total	
		Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure
Upper Mississippi	187,850	0.16	−0.04	0.30	0.00	0.50	0.08	0.96	0.04	0.24	0.03	0.20	0.00	0.48	0.18	0.92	0.21
Missouri	528,850	0.45	0.12	0.87	0.38	1.12	0.27	2.44	0.77	0.35	0.05	0.44	0.11	0.68	0.19	1.47	0.35
Ohio	205,900	0.37	−0.16	0.83	0.13	0.83	0.21	2.03	0.18	0.98	0.33	0.37	−0.16	0.58	−0.13	1.93	0.04
Arkansas-White	186,000	0.31	0.09	0.43	0.11	0.50	0.05	1.24	0.25	0.31	0.10	0.24	0.02	0.23	−0.09	0.78	0.03
Red	90,000	0.13	−0.04	0.35	0.12	0.29	−0.02	0.77	0.06	0.22	0.04	0.20	0.03	0.15	−0.08	0.57	−0.01
Lower Mississippi	54,300	0.12	−0.07	0.34	0.12	0.34	0.12	0.80	0.17	0.34	0.13	0.21	0.02	0.22	0.00	0.77	0.15
Total	1,250,900	1.54	−0.10	3.12	0.86	3.58	0.71	8.24	1.47	2.44	0.68	1.66	0.02	2.34	0.07	6.44	0.77

Subarea	Drainage (square miles)	1922										1927										Dec. 18-31, 1926		1927 total, including Dec. 18-31, 1926	
		January		February		March		April		Total		January		February		March		April		Total					
		Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure	Amount	Departure
Upper Mississippi	187,850	0.16	−0.05	0.31	−0.11	0.35	0.05	0.53	0.11	1.35	0.22	0.15	−0.06	0.15	−0.05	0.40	0.10	0.64	0.22	1.34	0.21	0.08	−0.01	1.42	0.20
Missouri	528,850	0.29	−0.01	0.44	0.11	0.89	0.39	1.48	0.63	3.10	1.12	0.25	−0.05	0.28	−0.05	0.63	0.14	1.59	0.74	2.75	0.78	0.07	−0.07	2.82	0.71
Ohio	203,900	0.44	−0.21	0.41	−0.12	0.92	0.21	0.66	0.04	2.43	−0.08	0.67	0.02	0.54	0.01	0.82	0.11	0.95	0.33	2.98	0.47	0.70	0.43	3.68	0.90
Arkansas-White	186,000	0.18	−0.03	0.21	−0.01	0.60	0.28	0.62	0.17	1.61	0.41	0.30	0.09	0.16	−0.06	0.48	0.16	0.69	0.24	1.63	0.43	0.22	−0.11	1.85	0.32
Red	90,000	0.19	0.01	0.22	0.05	0.40	0.17	0.36	0.05	1.17	0.28	0.17	−0.01	0.17	0.00	0.29	0.06	0.42	0.11	1.05	0.16	0.25	−0.15	1.30	0.01
Lower Mississippi	54,300	0.19	−0.02	0.21	0.02	0.36	0.14	0.16	−0.06	0.92	0.08	0.16	−0.05	0.18	−0.01	0.37	0.15	0.33	0.11	1.04	0.20	0.27	−0.17	1.31	0.03
Total	1,250,900	1.45	−0.31	1.80	0.16	3.52	1.24	3.81	0.94	10.58	2.03	1.70	−0.06	1.48	−0.16	2.99	0.72	4.62	1.75	10.79	2.25	1.59	−0.08	12.38	2.17

The following remarks are submitted with reference to the method of deriving the data entered in Table 5.

The entries in columns headed "Amount" are the amounts of precipitation computed as indicated in the description just quoted; the depth of the precipitation for each subarea is, however, expressed as the depth in inches and hundredths if spread over the entire drainage area, viz, 1,250,900 square miles.

The entries in the columns headed "Departure" were obtained from a set of weighted (for area only) normal precipitation tables for the several subareas, furnished through the courtesy of Mr. Montrose W. Hayes, in charge of the Weather Bureau office at St. Louis, Mo., working in conjunction with the Mississippi River Commission.

Attention is invited to the fact that the months January to March usually embraced the important flood rains; in the case of the 1922 and 1927 floods, however, it was necessary to include the month April, thus increasing the rain period to four months instead of three, as in the remaining floods. As a result, the total quantity of water available in the two last-named is greater than in the others, but since the object in presenting the data in this form is to facilitate the allocation of the flood producing rains to the several subareas that contributed it, this purpose is not affected by the use of a four rather than a three month rain period.

The time of occurrence and the spatial distribution of the precipitation govern the magnitude of the spring floods of the central and lower Mississippi River and its tributaries. Hitherto it has been considered an indisputable fact, and the previous records certainly sustain this conviction, that there can be no great flood in the Mississippi River below Cairo unless it should be preceded by a great and general Ohio River flood. But the flood of 1927 has apparently shattered this conviction so far as the section from the mouth of the Arkansas River southward is concerned. In the absence of definite figures the estimated discharge of the Arkansas and White Rivers, had the levees remained intact, certainly lend tentative support to this conclusion, and the primary reason therefor goes back to the almost saturated soil that had not been afforded an opportunity to dispose of the excess water received from the rains of the autumn of 1926.

The inclusion of the entire drainage area in Table 5 did not cause any material change in the relative order of flood magnitude as given in Table 10, MONTHLY WEATHER REVIEW SUPPLEMENT No. 22 (loc. cit.). The flood of 1912 apparently displaced that of 1882 by a margin of 0.56 inch of water over the entire basin. Otherwise the order would be the same, but of course with the flood of 1927 at the head. There can be no proper comparison between the floods of 1882 and 1912 from Cairo southward, as in 1882 the general levee system was virtually in its infancy, while in 1912 it was approaching completion. However, the excess precipitation over the upper Mississippi and Missouri Basins easily decides the question of magnitude. In both floods the Ohio Basin was, as usual, the decisive factor, but in 1882, when the flood was an early one, the precipitation was not unusual above Cairo, while in 1912 it was considerably over the normal amount from the extreme lower Missouri Basin eastward over the adjacent Mississippi Basin. Below Cairo conditions were much the same during both years, although of course the 1912 stages were higher.

When we come to compare the floods of 1922 and 1927, Table 5 does not disclose any significant differences, the totals being 10.58 inches for 1922 and 10.79 inches for 1927, excluding from the latter 1.59 inches that fell during the last two weeks of December, 1926. This 1.59 inches, of which nearly one-half came from the Ohio drainage, accounts for much of the superiority of the flood of 1927, although the torrential rains of April over the lower Arkansas Valley played an equally important part.

It therefore appears that, measured by the comparative depths of water precipitated over the entire drainage basin of the Mississippi River, the relative order of magnitude of six of the great floods of the last 45 years will be as follows: 1927, 1922, 1912, 1882, 1913, and 1903. But it must be remembered that precipitation figures are not the only important governing factors in flood causation. The spatial distribution of the precipitation and its amount in point of time are at least of equal importance.

Run-off.—In SUPPLEMENT No. 22 (loc. cit.) (The Spring Floods of 1922), pages 7 and 8, there were exhibited the rainfall (uniform cover) and the total discharge over the abridged drainage area described on pages 8 and 9. The discharge figures were based upon the average ratio of discharge to precipitation as assumed by Humphreys and Abbott and by Greenleaf and were as follows:

Ratio of discharge to precipitation

Basin:	Ratio
Ohio	0.30
Upper Mississippi	.28
Missouri	.15
Arkansas	.16
Red	.22
Lower Mississippi	.52
Entire basin	.25

In Bulletin E, Floods of the Mississippi River, Weather Bureau, 1897, Morrill computed the normal annual discharge of the entire Mississippi Basin to be 785,190,000,000 cubic yards, using as a basis certain deductions made by Humphreys and Abbott.[1] In 1926 and 1927, Messrs. M. W. Hayes and W. J. Moxom, of the St. Louis Weather Bureau Office, computed the normal annual precipitation of the basin in terms of the weighted monthly means of the individual subbasins multiplied by the ratios between the subbasin areas and the area of the entire basin. They found the normal annual precipitation to be 30.11 inches. Using 0.25 as the ratio of discharge to precipitation we obtain as the present total annual discharge 810,174,940,640 cubic yards, which differs from the figures obtained by Morrill by only 3 per cent, a remarkable agreement when we take into consideration the limited data available during the last century.

No discharge figures for 1927 are available, and therefore the above procedure was followed except that on account of the important part played in 1927 by the Missouri and upper Mississippi Valleys the entire drainage area was used, and the discharge data for the floods of 1882, 1903, 1912, 1913, and 1922 recomputed on that basis. While the results, of course, are only the product of average conditions, they may nevertheless afford some comparative idea of the amount of water that actually entered the streams at some point or other. Attention is invited to the fact that much of the winter precipitation over that portion of the drainage basin of the Mississippi River above the mouth of the Missouri and that of the Missouri River above the mouth of the Platte is in the form of snow of which very little is contributed to the actual run-off. Therefore, the winter figures for the districts mentioned are probably in excess to a fair amount. Data for the six floods are given in Table 6 following:

[1] Section on Hydrology in Report on the Water Power of the Mississippi River, Tenth Census.

TABLE 6.—*Approximate discharge, for six floods, in millions of cubic yards*

Subarea	1882				1903				1912				1913			
	January	February	March	Total	January	February	March	Total	February	March	April	Total	January	February	March	Total
Upper Mississippi	5,123	14,767	13,260	33,150	3,014	7,232	9,945	20,191	4,822	9,041	15,068	28,931	7,233	6,027	14,465	27,725
Missouri	3,229	8,879	7,104	19,212	3,713	8,556	7,588	19,857	7,265	14,046	18,082	39,393	5,651	7,103	10,978	23,732
Ohio	30,351	29,706	23,570	83,627	10,655	27,768	19,051	57,474	11,947	26,800	26,800	65,547	31,643	11,947	18,727	62,317
Arkansas-White	4,133	8,094	5,338	17,565	1,894	8,610	4,650	15,154	5,338	7,405	8,610	21,353	5,338	4,133	3,961	13,432
Red	8,287	6,867	4,736	19,890	3,078	9,708	6,156	18,942	3,078	8,287	6,867	18,232	5,209	4,736	3,552	13,497
Lower Mississippi	20,708	17,350	14,551	52,609	9,514	18,469	13,992	41,975	6,717	19,029	19,029	44,775	19,029	11,753	12,312	43,094
Total	71,831	85,663	68,559	226,053	31,868	80,343	61,382	173,593	39,167	84,608	94,456	218,231	74,103	45,699	63,995	183,797

Subarea	1922					1927					Dec. 18–31, 1926	Total, including Dec. 18–31, 1926
	January	February	March	April	Total	January	February	March	April	Total		
Upper Mississippi	4,822	9,342	10,548	15,972	40,684	4,520	4,520	12,055	19,287	40,382	2,411	42,793
Missouri	4,682	7,103	14,368	23,894	50,047	4,036	4,520	10,171	25,669	44,396	1,130	45,526
Ohio	14,207	13,238	29,706	21,310	78,461	21,633	17,436	26,477	30,674	96,220	22,502	118,822
Arkansas-White	3,100	3,616	10,332	10,677	27,725	5,166	2,755	8,266	11,882	28,069	3,788	31,857
Red	4,499	5,209	9,471	8,524	27,703	4,025	4,025	6,867	9,945	24,862	5,919	30,781
Lower Mississippi	10,634	11,753	20,148	8,955	51,490	8,955	10,074	20,708	18,469	58,206	15,111	73,317
Total	41,944	50,261	94,573	89,332	276,110	48,335	43,330	84,544	115,926	292,135	50,961	343,096

The figures in the above table although of course only close approximations show clearly the supremacy of the floods of 1927 and 1922 above all others, as well as the outstanding supremacy of the flood of 1927. Moreover the great excess discharge in April, 1927, affords a sufficient explanation of the increased magnitude of the flood of 1927. It is noted also that the greater portion of the excess of 1927 came from the Ohio and lower Mississippi drainage, especially the Ohio. It also appears further that the total discharge for January and February for the two floods, 1922 and 1927, did not differ materially, March and April, 1927, virtually supplying the entire excess over 1922.

The total volume of water supplied by the rain in 1927 was 244.4 cubic miles for the period from December 18,1926, to April 30, 1927, and 213 cubic miles for the period from January 1 to April 30, 1927. The total discharge for 1927 computed on a basis of 27 per cent of the water over the area was 66 cubic miles for the long period, and on a basis of 26 per cent, 55.4 cubic miles for the short period. The total movement of water of the Gulf Stream through the Straits of Florida in one day of 24 hours is 240.7 cubic miles,[1] or 3.7 cubic miles less than that that fell in the form of rain over the drainage basin of the Mississippi River from December 18, 1926, to April 30, 1927.

Probability of greater floods.—What would have been the actual crest stages in 1927 from Paducah to New Orleans had all levees remained intact and the amount and distribution of precipitation been the same? This question does not appear to be difficult to answer within reasonable limits of correctness for the section between Cairo and Helena, but below Helena there must be a certain measure of speculation owing to the difficulty of accurate determination as to the volume of water diverted through the crevasses from the main channels. This is particularly true for Arkansas City, Ark., for it is believed that the discharge data computed by the United States Engineer Corps will show the greatest run-off ever recorded in the lower Arkansas and lower White Rivers. The flood crest in the lower Arkansas as measured by the gage heights at Little Rock was only 1.6 feet lower than that of June, 1833, at which time there could not have been any levees of consequence, leaving the fair inference that the discharge at Arkansas City would have been greater in 1927 had the levees held. The situation at Arkansas City was further complicated by the great crevasse at Mounds Landing, Miss., almost directly opposite Arkansas City. This crevasse occurred almost simultaneously with the maximum stage of 60.5 feet at Arkansas City on the morning of April 21.

Table 7, below gives for Paducah, Ky., and Cairo, Ill., on the Ohio River and various places on the Mississippi River from St. Louis to New Orleans the estimated stages that would have been reached in 1927, had all levees remained intact, and without intervening heavy rains other than those that occurred after the crest had passed Cairo. The table also gives the estimated greatest possible stages that could occur in the future under the most favorable conditions of flood causation. Before this table was prepared the opinions of the officials in charge of some of the Weather Bureau stations within the district were invited, and due regard was had to these. It is admitted that the established progress of meteorological conditions across the country makes the occurrence of such a superflood very remote, yet it is not absolutely beyond the limits of possibility.

TABLE 7.—*Possible crest stages during flood of 1927 with all levees intact; also estimated stages of maximum flood that could occur*

Station	Possible 1927 stages	Maximum possible stages	Station	Possible 1927 stages	Maximum possible stages
Paducah, Ky.	48.0	65.0–65.5	Arkansas City, Ark.	68.5–69.0	72.5–73.0
Cairo, Ill.	57.7–58.0	65.5–66.0	Greenville, Miss.	61.5–62.0	65.5–66.0
St. Louis, Mo.	36.1	45.4–46.4	Lake Providence, La.	59.0–59.5	63.0–63.5
Cape Girardeau, Mo.	41.5	51.4–52.4	Vicksburg, Miss.	64.5–65.0	68.5–69.0
New Madrid, Mo.	45.0–45.3	51.0–51.5	Natchez, Miss.	64.5–65.0	68.5–69.0
Cottonwood Point, Mo.	43.0–43.3	46.5–47.0	Baton Rouge, La.	54.5–55.0	58.5–59.0
Memphis, Tenn.	47.2–47.5	54.5–55.0	Donaldsonville, La.	44.5–45.0	48.5–49.0
Helena, Ark.	58.2–58.5	66.0–66.5	New Orleans, La.	27.2–27.7	29.5–30.0

As the problem is one that is of much importance in connection with the subject of future flood control, we will now discuss at some length the reasoning that led to the evolution of the figures given in Table 10.

[1] Findlay, Alex. Geo., Ocean Meteorology, 1887. Page 67.

STAGES FOR 1927

Cairo, Ill.—The actual crest stage was 56.4 on April 20. The crevasse at Dorena, Mo., 30 miles below Cairo, occurred at 4 a. m. April 16, and after that time the river at Cairo rose only 0.7 foot, notwithstanding the fact that the Mississippi at St. Louis was rising steadily and continued to do so for nearly a week after. The Ohio at Paducah also continued to rise for a few days after the crevasse. The rises at St. Louis and Paducah after the Dorena crevasse were about 2 and 0.9 foot, respectively, with an increase of only 0.7 foot on the Cairo gage. It is apparent then, if the Dorena crevasse had not occurred, the crest stage at Cairo would have been 57.7 to 58 feet about but not after the end of April. With a flood in the upper Ohio equal to that of 1913 the crest at Cairo would probably have been approximately 62 feet.

Paducah, Ky.—As the stages at Paducah under existing conditions were partly due to backwater from the mouth of the river, some of the additional rise allowed for Cairo would be reflected on the Paducah gage, and, allowing for a difference of about 9.5 feet between Paducah and Cairo with a one-day interval, the highest stage at Paducah would have been very close to 48 feet. The actual crest was 47.2 feet on April 18.

St. Louis, Mo.—There is nothing to indicate that there would have been any change in the crest at St. Louis, except possibly two or three-tenths of a foot. The actual crest was 36.1 feet on April 26, six days after the crest occurred at Cairo.

Cape Girardeau, Mo.—Damming effect from Cairo is also pronounced at Cape Girardeau, and this combined with the additional rise of 2 feet coming from St. Louis would have added about 1.5 feet to the recorded crest of 40 feet on April 20, making a probable crest of 41.5 feet.

New Madrid, Mo., Cottonwood Point, Mo., and Memphis, Tenn.—For these places the problem becomes the much simpler one of applying the normal differences between them and the estimated crest for Cairo. Doing this we would have—

Cairo	New Madrid		Cottonwood Point		Memphis	
	Difference	Crest	Difference	Crest	Difference	Crest
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
57.7-58 feet	−12.7	45-45.3	−14.7	43-43.3	−10.5	47.2-47.5

Helena, Ark.—Here the problem is complicated through the influence of the stages at Arkansas City, Ark., upon those at Helena. In 1927 the stage at Arkansas City would have been so high that it would have exercised a slight damming effect and increased the stage at Helena accordingly. Making due allowance of about 0.5 foot for this, the Helena crest, based upon Cairo, would have been from 58.2 to 58.5 feet.

Arkansas City, Ark.—The situation here was a very complex one on account of the enormous volume of water from the Arkansas and White Rivers and the great crevasses along those rivers and at Mounds Landing, Miss., almost directly opposite Arkansas City. With Cairo at 56.4 feet on April 20, the crest stage at Arkansas City without crevasses and without abnormal increment from the Arkansas and White Rivers would have been approximately 60.5 feet about the end of April, whereas this stage was reached on April 21, the excess coming from the Arkansas and White waters. Without this great excess from the Arkansas Basin the stage on April 21 would have been between 57.6 and 58 feet instead of 60.5 feet. Therefore the probable crest at Arkansas City in 1927 with levees intact would have been 57.5 to 58 + 4 additional rise to come from Cairo plus about 7 from the Arkansas and White, or about 68.5 to 69 feet. Incidentally the crest stage at Little Rock would have been higher than the 33 feet reached on April 20, and the lower White would also have been higher.

Greenville, Miss.—By applying the normal difference of about 6 feet that actually prevailed between Arkansas City and Greenville, and −1 foot for banking effect at Arkansas City, we would have had for Greenville in 1927 under the conditions assumed, 68.5 to 69 feet for Arkansas City −7 = 61.5 to 62 feet. At Lake Providence, La., the crest would have been about 2.5 feet lower than at Greenville; that is, 59 to 59.5 feet.

Vicksburg, Miss.—Applying the normal difference of 3 feet between Arkansas City and Vicksburg, and minus about 1 foot for banking effect at Arkansas City, we have for Vicksburg 68.5 to 69 − 4 = 64.5 to 65 feet.

Natchez, Miss.—Assuming Vicksburg and Natchez crests to be approximately the same at very high stages, we obtain Natchez probable crest as 64.5 to 65 feet.

Baton Rouge, La.—With unbroken levees the normal difference between Natchez and Baton Rouge will be about 11 feet, but with the Red also very high, as it was in 1927, the difference would have been reduced to at least 10 feet and the crest at Baton Rouge would therefore have been 64.5 to 65 − 10 = 54.5 to 55 feet.

Donaldsonville, La.—At very high stages the difference between Baton Rouge and Donaldsonville is approximately 10 feet. Assuming these figures to be correct, the unimpeded crest at Donaldsonville in 1927 would have been 54.5 to 55 − 10 = 44.5 to 45 feet.

New Orleans, La.—Forecasts of flood stages at New Orleans must always take into consideration the possible effect of tides and wind direction and velocity. While these factors are of great importance at times, they must be disregarded in any computation of gage relations, and therefore a liberal allowance must be made as a factor of safety. It appears that with a stage of 34 feet on the Donaldsonville gage, the difference between the Donaldsonville and New Orleans crests will be approximately 14 feet, increasing gradually at the rate of 0.3 per foot as the Donaldsonville crests increase, so that with Donaldsonville at 45 feet, the difference between Donaldsonville and New Orleans (Carrollton gage), would be about 17.3 feet. Applying this difference we have 44.5 to 45 − 17.3 = 27.2 to 27.7 feet for New Orleans. These figures for New Orleans appear to be very high, and possibly the increase in the difference between Donaldsonville and New Orleans at very high stages may be a little more than 0.3 foot for each foot of rise at Donaldsonville.

MAXIMUM FLOOD POSSIBILITIES

Again the counsel of several officials of the Weather Bureau was invited, and the conclusions given below, while they are largely speculative, represent the combined judgment of those in the Weather Bureau who have given attention to the problem. Let us begin again with Paducah and Cairo. On February 14, 1884, the crest stage of the Ohio River at Cincinnati was 71.1 feet, and on April 1, 1913, 69.9 feet. The corresponding crests at Paducah were 54.2 and 54.3, and at Cairo 52 and 54.7 feet. The Mississippi at St. Louis was below 15 feet in 1884 and between 21 and 25 feet in 1913, while the stages in the tributaries of the Ohio were only moderately high in 1884 and exceptionally high in 1913. The Ohio flood

of 1884 was largely a high temperature and snow flood with only moderately heavy rains. It is not difficult to conceive of heavier rains under the same conditions with a maximum stage of at least 75 feet at Cincinnati. Under normal conditions of precipitation distribution and resultant streamflow, and without high water in the Mississippi River the crest at Paducah with 75 feet at Cincinnati would be about 57 feet and at Cairo 57.5 feet. Add to these 6 feet for a possible crest of 45 feet at St. Louis, and also about 2.5 feet additional for an excess in the Cumberland and Tennessee, not present in 1884 and 1913, and we obtain for Paducah 57+6+2.5=65.5, and for Cairo 57.5+6+2.5=66 feet. These calculations are based upon the Mississippi, Cumberland, and Tennessee Rivers contributing their tides at just the proper time to insure the greatest effect at Paducah and Cairo, an improbable occurrence, it is admitted, but nevertheless a remotely possible one.

St. Louis, Mo.—Flood heights in St. Louis have been raised since 1903 by the protective works at East St. Louis, Ill., how much is not known exactly, but possibly as much as 2 feet, which in 1844 would have made the flood 41.4+2=43.4 feet on the St. Louis gage. There is no record of a very great flood in 1844 in the Mississippi River as far north as Hannibal, Mo., where the highest water of record was 22.5 feet in June, 1903, nor in the northern tributaries of the Missouri River within the State of Missouri. It would be fair to allow an additional 2, or possibly 3, feet against a future flood of 22.5 feet or higher at Hannibal, and greater floods in the northern Missouri tributaries. Then we would have 43.4+2 to 3=45.4 to 46.4 feet as a possible stage for St. Louis.

Cape Girardeau, New Madrid, and Cottonwood Point, Mo., Memphis, Tenn., and Helena, Ark.—The maximum possible stages given in Table 10 were determined by coordinate plot from Cairo, except that at Helena an additional allowance of +0.5 foot was made for damming effect from Arkansas City, Ark.

Arkansas City, Ark.—Assuming a normal relation between Cairo and Arkansas City, and Arkansas and White River floods as great or a little greater than in 1927, we would obtain for the maximum flood at Arkansas City 65.5 to 66+4 for Cairo difference, +3 for additional Arkansas and White River water =72.5 to 73 feet, alarming figures, yet they appear to be reasonable in the rather improbable event that antecedent conditions proved to be most favorable. Let us remember also that a Canadian River flood, which did not occur in 1927, could easily add a foot or two to a lower Arkansas flood.

Greenville, Miss., Lake Providence, La., Vicksburg, and Natchez, Miss.—These stages were determined by coordinate plot from Arkansas City, except that an additional allowance of −1 foot was made for banking effect at Arkansas City.

Baton Rouge, La.—As stated before, with Red River in very great flood, the normal difference of about 11 feet between Natchez and Baton Rouge would be reduced at least 1 foot, and we would therefore have as the maximum for Baton Rouge 68.5 to 69 −10 =58.5 to 59 feet.

Donaldsonville, La.—Applying the normal difference of about 10 feet between Baton Rouge and Donaldsonville, we obtain as the maximum for Baton Rouge, 58.5 to 59 −10 =48.5 to 49 feet.

New Orleans, La.—Again a very indeterminate quantity, but if we assume the original possiblility of 27.2 to 27.7 feet in 1927, or even a little lower stage, it is probably not unreasonable to place the maximum possible stage at 29.5 to 30.5 feet.

We again emphasize that while the figures given in Table 7 represent only a very remote probability, they are not entirely beyond the bounds of ultimate possibility. According to Cline, the flood of 1927 surpassed any previous overflow below Vicksburg in something like 200 years, and a second 200 years, or even more, might and probably would elapse before the appearance of a flood that would be as great or greater. Time alone can determine, but it must not be forgotten that the two greatest floods of history in the lower Mississippi River occurred in 1922 and 1927, an interval of only 5 years.

The total area of lands overflowed by the flood water of 1927, as obtained by officials of the Weather Bureau, was 18,268,780 acres, or 28,545 square miles. As the river districts of the bureau are necessarily arranged without regard to State boundaries, it is impossible to properly allocate to the States concerned their proper proportions of the total acreage overflowed. However, a few individual State totals which are not absolutely correct, were as follows:

	Acres
Tennessee	505, 000
Mississippi	5, 032, 000
Arkansas	4, 224, 000
Kansas	77, 100
Oklahoma	265, 000
Texas	6, 000
Total	10, 109, 100

The distribution of overflowed areas by Weather Bureau river districts, which are outlined in the district reports, was as follows:

	Acres
St. Louis, Mo	86, 400
Cairo, Ill	630, 880
Memphis, Tenn	1, 935, 000
Vicksburg, Miss	5, 032, 320
New Orleans, La	6, 382, 080
Nashville, Tenn	23, 000
Little Rock, Ark	3, 648, 000
Shreveport, La	157, 000
Fort Smith, Ark	265, 000
Topeka, Kans	77, 100
Missouri River above Kansas City, Mo	50, 000
Total	18, 286, 780

An estimate of the total area of crop lands flooded was prepared by the Bureau of Agricultural Economics of the United States Department of Agriculture, and the figures obtained were as follows:

	Acres
Arkansas	1, 839, 400
Louisiana	1, 112, 200
Mississippi	861, 900
Missouri	359, 000
Tennessee	195, 000
Kentucky	50, 000
Total	4, 417, 500

Of the total of 4,417,500 acres of overflowed crop lands, there were grown in 1926, according to the Bureau of Agricultural Economics, about 2,600,000 acres of cotton, 1,100,000 acres of corn, 360,000 acres of hay, and about 357,500 acres of other crops. Of course much of the overflowed land was afterwards replanted, but how much is not now known. However, large acreages were reoverflowed after replanting, especially in southeastern Arkansas where there were really four overflows.

The acreage of crop lands overflowed was a little more than 24 per cent of the total overflowed area, which is perhaps a little less than the usual ratio between cultivated and uncultivated lands. However, the figures for crop lands did not include the overflowed areas in Kansas, Oklahoma and some scattered acreages. Over these the total overflow on lands of every description was 415,100

acres. Deducting this amount from the total of 18,286,780 acres, there remain 17,871,680 acres, making the percentage of crop lands overflowed 24.7, about the usual ratio.

LOSS OF LIFE IN THE FLOOD

Until the year 1927 loss of human life in lower Mississippi floods for the last 60 years at least, has been so small as to be virtually negligible. The relatively distant origin of the floods and their slow, deliberate movement permit their approach to be heralded many days in advance and there is always ample time for all affected to remove or be removed from places of danger. Owing to the natural reluctance of many of those not generously endowed with the necessities and comforts that contribute to material well being, to abandon the little they may happen to possess, it has often been necessary to remove them more or less forcibly, but nevertheless in time, as a rule, to avoid catastrophe.

During the great floods of 1897, 1903, 1912, 1913, and 1922 there were no losses of human life that were directly attributable to the flood, but the flood of 1927 proved to be a sad exception. The death statistics for this flood were compiled very carefully, and they are as follows:

Cairo, Ill., district	11
State of Arkansas	127
Memphis, Tenn., district	34
State of Mississippi	42
Total	214

There were also 4 lives lost on the Verdigris River at Gibson Station, Okla., 1 at Kansas City, Mo., 89 in Kentucky, and 5 in Virginia and North Carolina, making in all a total of 313. The deaths in Kentucky, Virginia, and North Carolina occurred in the mountain districts in the month of May.

LOSS AND DAMAGE

When the time arrived to ascertain the extent of loss and damage caused by the floods and to connect them with dollars and cents, the usual difficulties arose, the same difficulties that attend any flood whether great or small. Of course the diverse and oftentimes intangible character of the damage precludes any hope of absolutely reliable statistics. For reasons that need not now be mentioned, the almost invariable tendency is to underestimate loss and damage. Nevertheless careful and conscientious endeavors were made by the officials in charge of the various river districts to obtain data of this character that would be at least reasonably reliable, and the results are given below. Except in a few instances, tabulation by individual States was not possible with the data at hand, as Weather Bureau river districts are organized without regard to State boundaries. Railroad losses, which must have been very large, are not included except in a few instances.

Detailed reports of the flood in the several river districts are presented by the following named Weather Bureau officials:

	River district
Montrose W. Hayes	St. Louis.
William E. Barron	Cairo.
Frederick W. Brist	Memphis.
Robert T. Lindley	Vicksburg.
Isaac M. Cline	New Orleans.
Truman G. Shipman	Fort Smith.
Harvey S. Cole	Little Rock.
James W. Cronk	Shreveport.

Lack of space prevents us from entering upon the full details as recited in Monthly Weather Review, Supplement No. 29, to which the reader is referred.

TABLE 8.—*Loss and damage from flood*

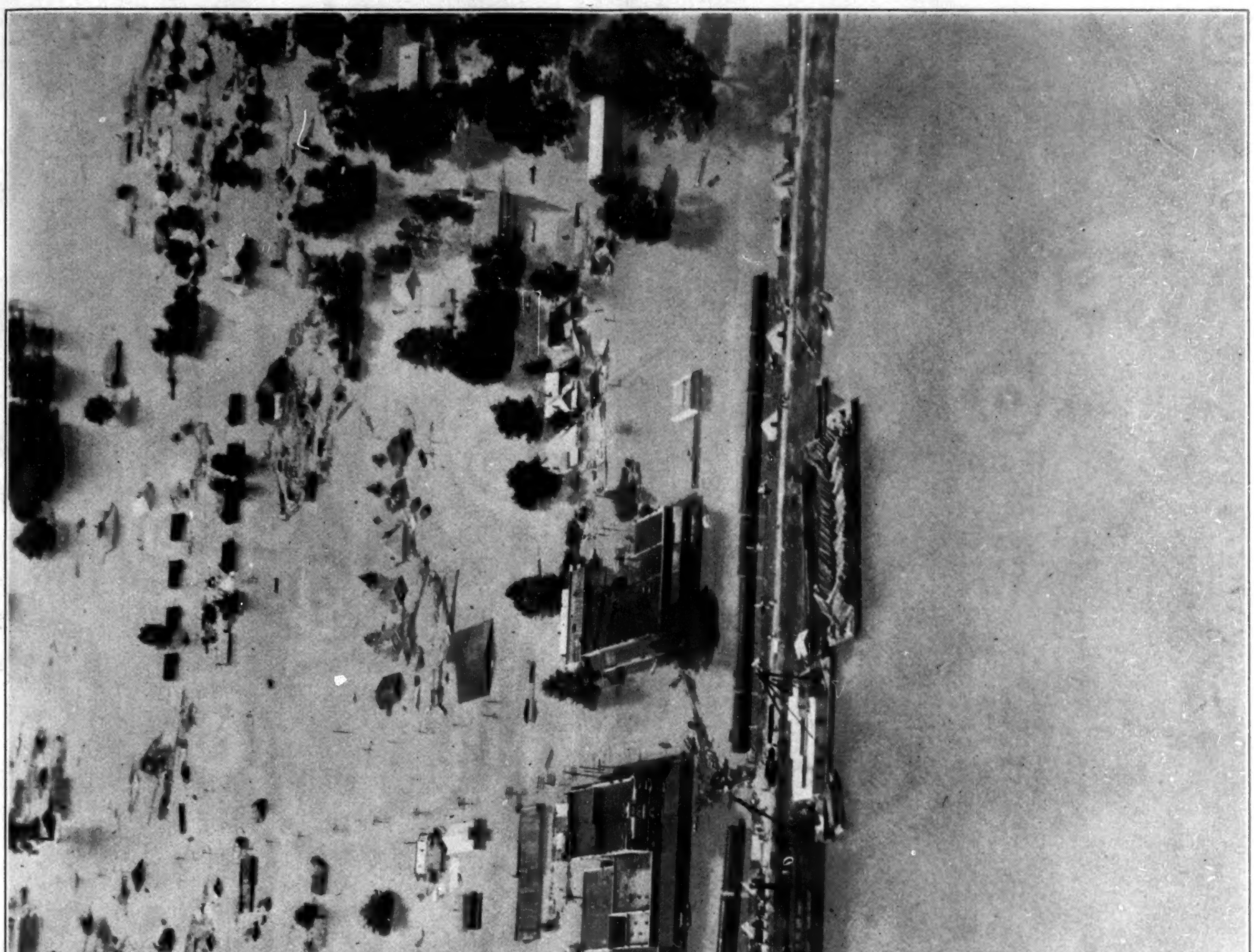
District	Territory	Loss and damage					Total
		Miscellaneous	Crops	Livestock and other farm property	Protection work	Suspension of business	
Indianapolis, Ind	Indiana	$128,150					$128,150
Nashville, Tenn	Tennessee and Kentucky	218,000					218,000
Knoxville, Tenn	Virginia and North Carolina	50,000	$25,000				75,000
Louisville, Ky	Kentucky	7,000,000					7,000,000
Missouri River, South Dakota to Kansas City, Mo.	South Dakota, Iowa, and Nebraska	201,500	797,250				998,750
Hannibal, Mo	Iowa and Missouri	5,000				$18,000	23,000
St. Louis, Mo	Missouri and Illinois	4,872,000	[1] 8,382,000			839,000	14,093,000
Cairo, Ill	Illinois, Missouri, Tennessee, and Kentucky	2,054,692	1,713,050	$306,300	$600,000	807,821	5,481,863
Memphis, Tenn	Tennessee and Arkansas	6,734,450	10,236,595	593,350	218,508	10,268,565	28,051,468
Vicksburg, Miss	Mississippi and Louisiana	[2] 14,500,000	[2] 50,000,000	[2] 15,000,000	[2] 15,000,000	[2] 10,000,000	[2] 104,500,000
New Orleans, La	Louisiana and Arkansas	30,000,000	22,000,000	6,250,000	15,000,000	28,000,000	101,250,000
Topeka, Kans	Kansas	418,500	376,000	73,000		102,500	970,000
Fort Smith, Ark	Kansas, Oklahoma, and Arkansas	1,770,400	3,532,000	90,000		325,000	5,717,400
Little Rock, Ark	Arkansas	8,386,000	3,654,000	637,000		1,259,000	13,936,000
Shreveport, La	Texas, Louisiana, Oklahoma, and Arkansas	560,000	846,500	136,500		132,000	1,675,000
Total		76,898,692	101,562,395	23,086,150	30,818,508	51,751,886	284,117,631

[1] Includes livestock and other movable farm property. [2] Estimated.

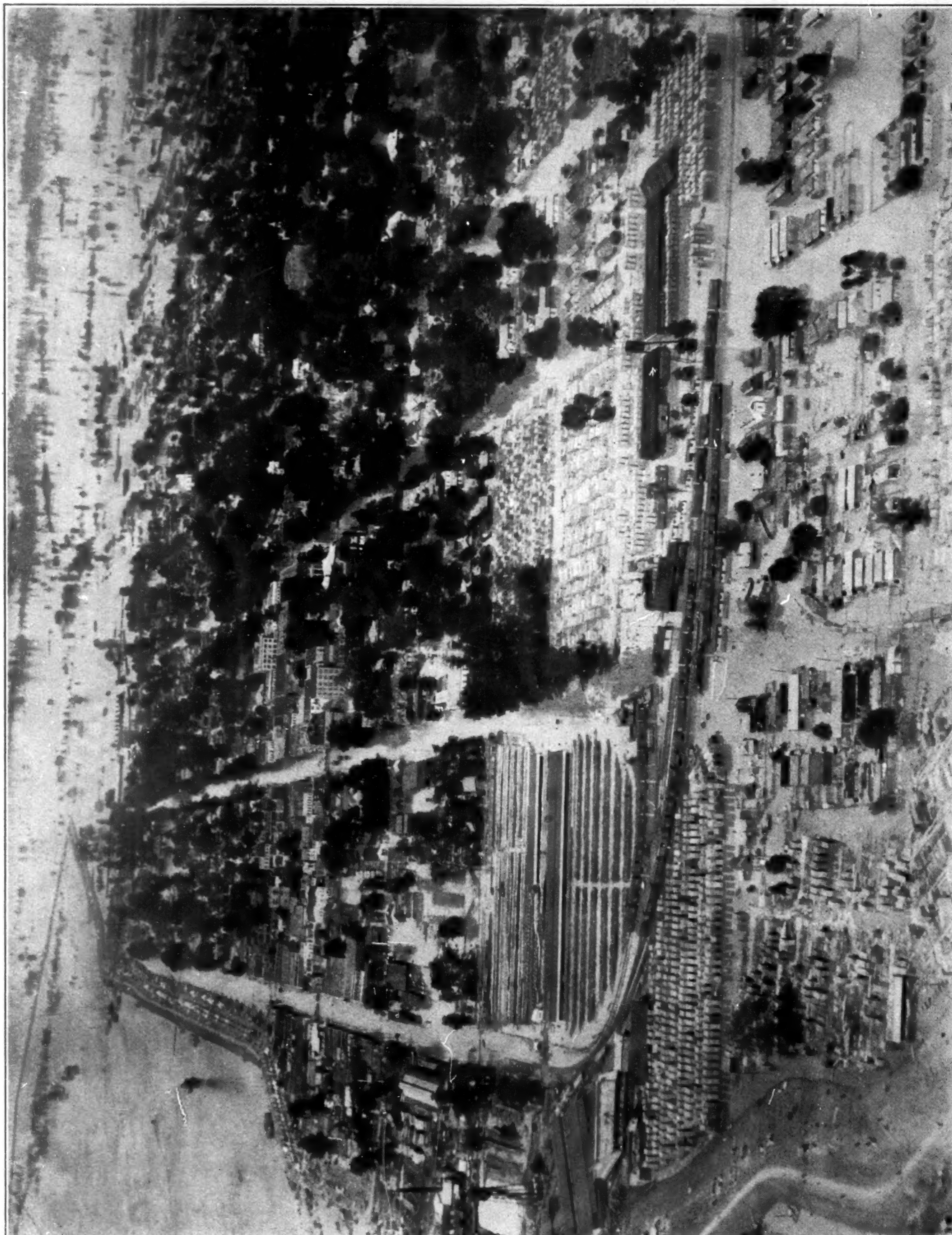
TABLE 9.—*Livestock losses, by States, flood of 1927*

	Arkansas		Louisiana		Mississippi		Missouri		Tennessee		Total	
	Number	Value	Number	Value	Number	Value	Number	Value	Number	Value	Number	Value
Horses and mules	9,250	$490,250	7,100	$475,700	7,375	$538,375	1,000	$55,000	600	$37,200	25,325	$1,596,525
Cattle	21,060	459,108	19,630	427,934	9,000	189,000	Slight		800	24,320	50,490	1,100,362
Swine	66,590	632,605	55,930	531,335	22,690	242,783	considerable		2,900	37,700	148,110	1,444,423
Sheep	310	1,798	740	2,220	250	825	Slight		0	0	1,300	4,843
Poultry	525,440	352,045	487,830	365,872	263,300	192,209	Heavy				1,276,570	910,126
Total	622,650	1,935,806	571,230	1,803,061	302,615	1,163,192	1,000	55,000	4,300	99,220	1,501,795	5,056,279

NOTE.—No data for Kentucky.



Greenville, Miss., April 27, 1927. River stage 52.8 feet. (Airplane photograph)



Arkansas City, Ark., April 27, 1927. River stage 52.8 feet. (Airplane photograph)

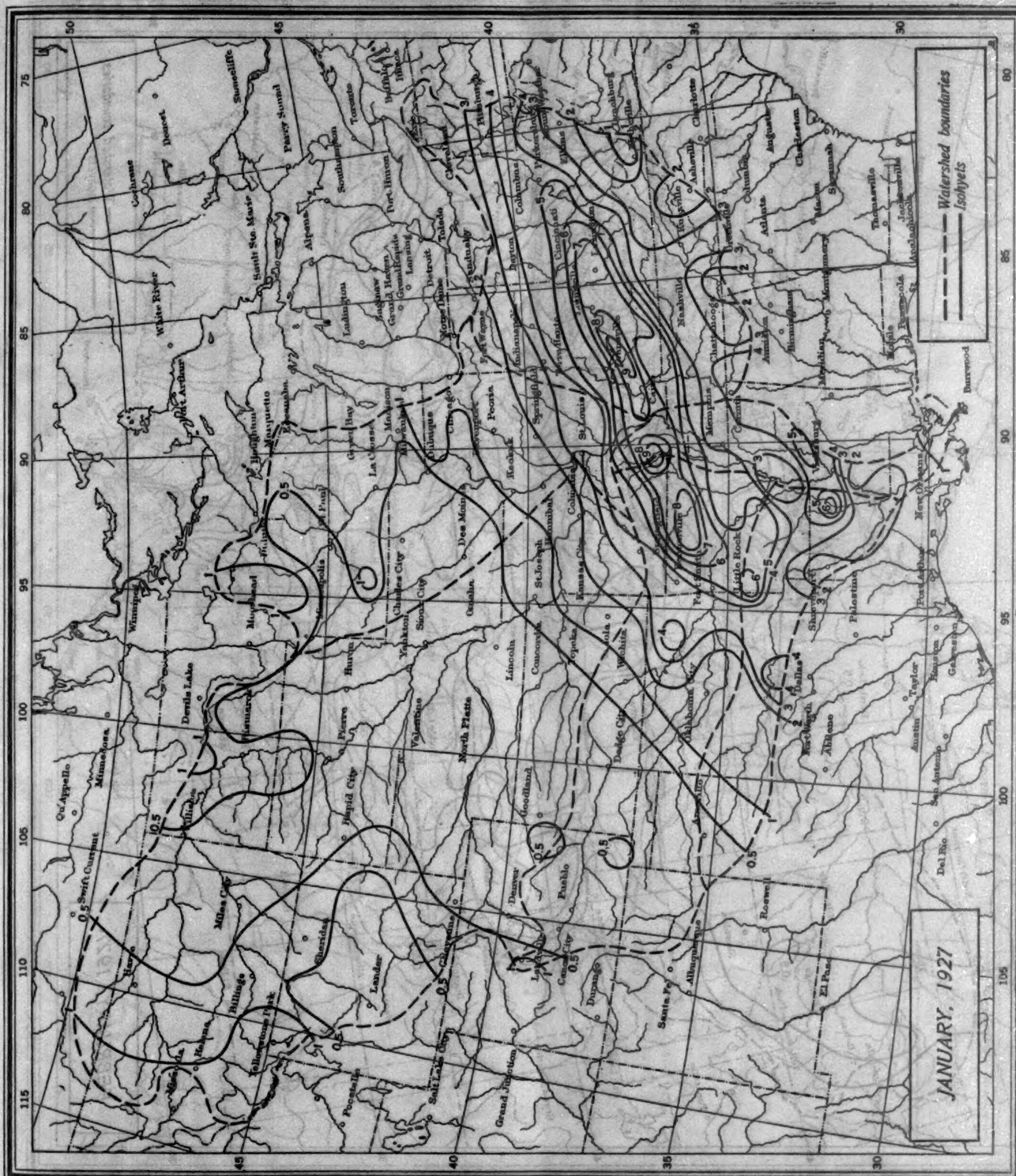


FIG. 7.—Precipitation for January, 1927

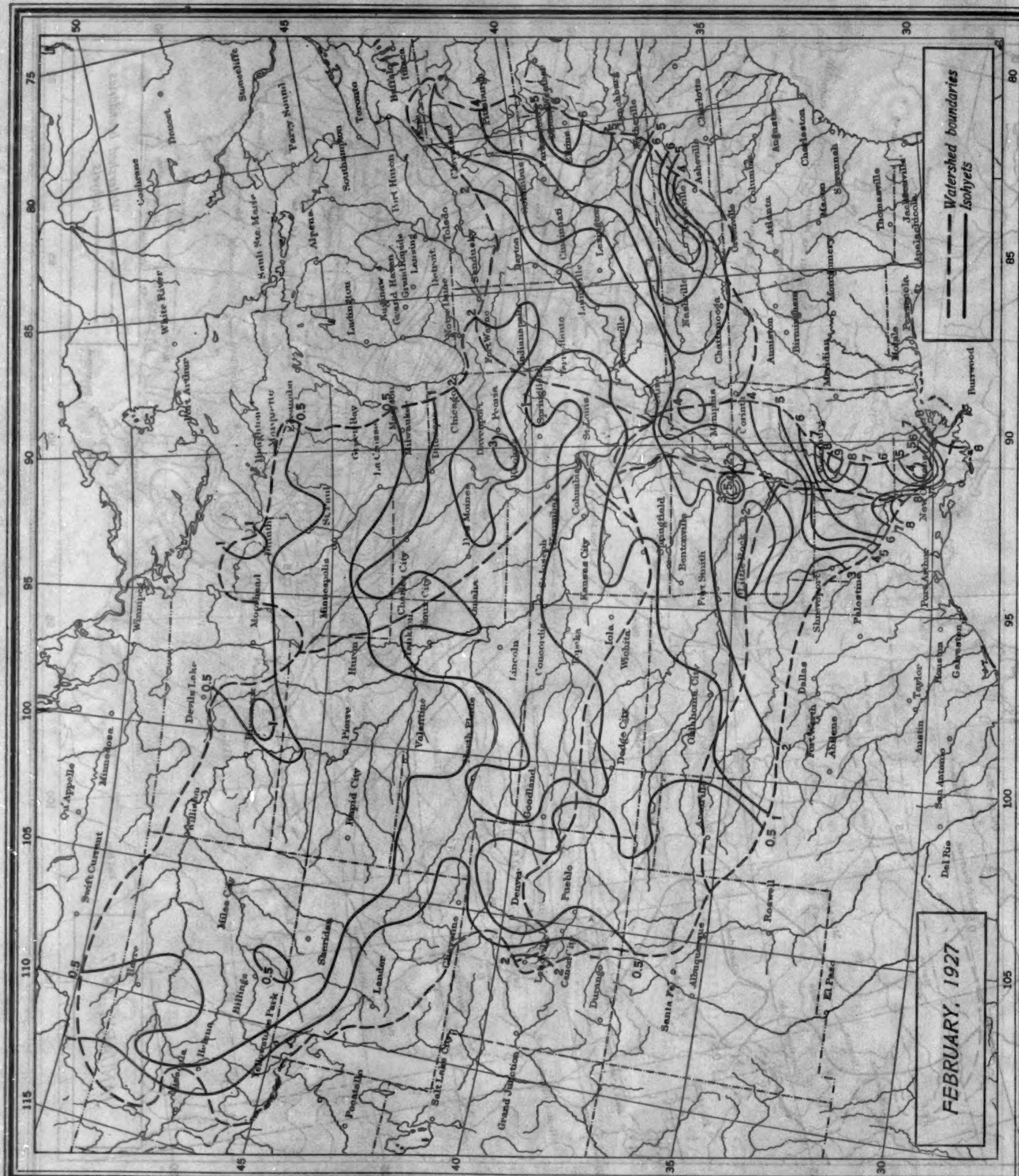


FIG. 9.—Precipitation for February, 1927

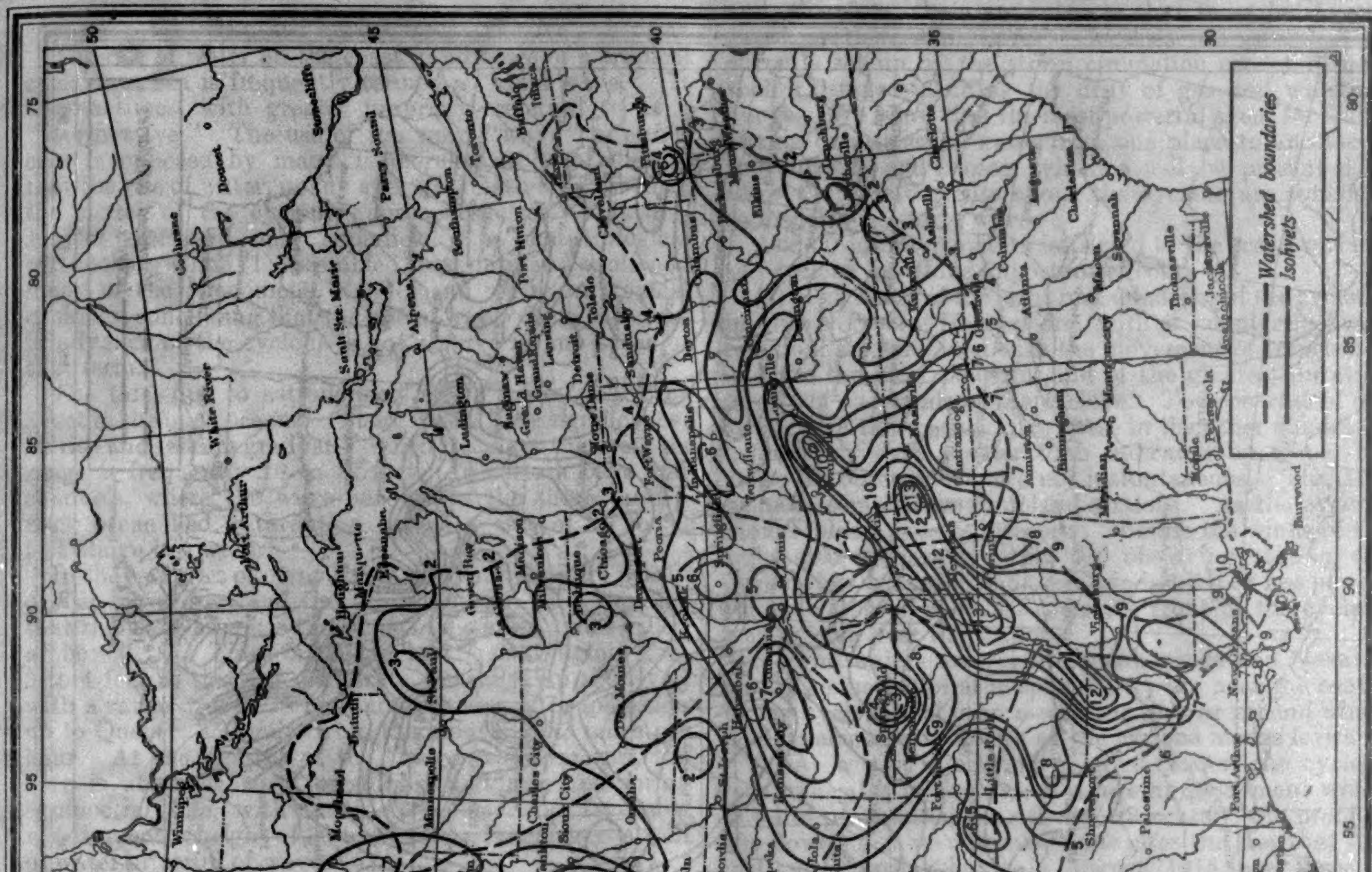


FIG. 9.—Precipitation for March, 1927

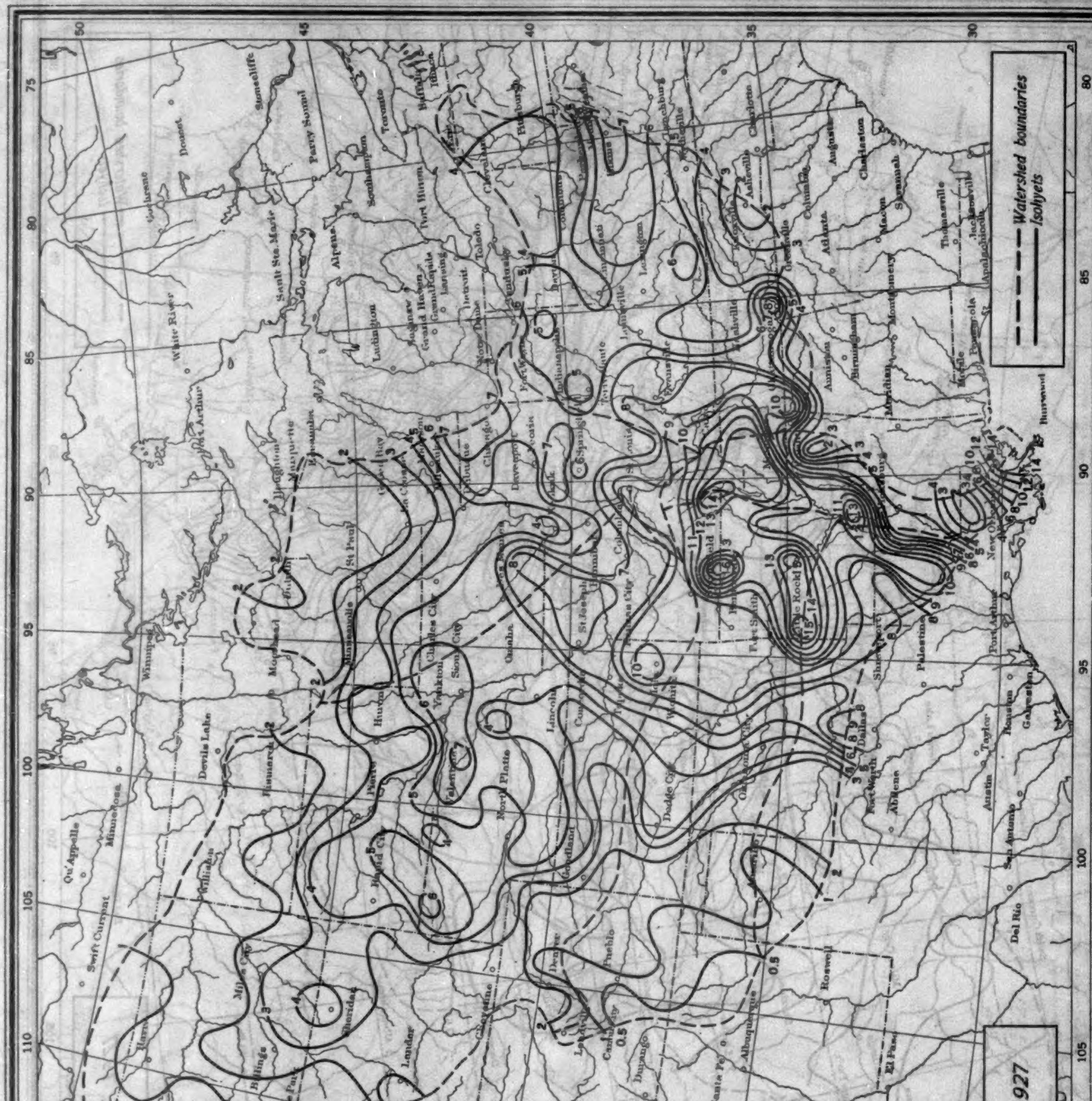


FIG. 10.—Precipitation for April, 1927

SOME INUNDATIONS ATTENDING TROPICAL CYCLONES

By I. R. Tannehill

[Weather Bureau, Galveston, Tex., November 1, 1927]

The rise of water on the coast in advance of a tropical cyclone at sea is frequently termed a "tidal wave." It is sometimes, with greater propriety, referred to as a "storm wave." The use of the word "wave" in either case is opposed by many meteorologists who contend that the rise of water, in any event, is relatively slow until the center of the cyclone approaches closely. It is a subject discussed only superficially in meteorological textbooks. Cline (1) assembled tidal data and explained many of the phenomena of tides and waves in tropical cyclones, concluding that the rise of water along the coast in advance of the cyclone is not a wave in any sense of that term.

The tide, due to astronomical causes, rises only 2 or 3 feet in the open oceans. There it is of little significance; its rise and fall are gradual. When it strikes the coast its range is frequently 10 to 12 feet. In certain bays and channels, where the wave encounters the shores and a risng ocean bed, retardation causes a tide of 25 to 50 feet above low water.

In the estuaries of many rivers vast sand flats are nearly dry at low water, and the tide rises with such rapidity that the wave assumes the shape of a wall of water called a "bore." (2) Tides in the St. Lawrence, ranging from 3 to 4 feet in the gulf, penetrate 450 miles up the river, with a range of 9 to 18 feet, and the rate of propagation up to Quebec, 350 miles from the mouth, is 83 miles per hour. At the mouths of the Ganges and Amazon, the bore is at times very formidable and may, at spring equinoctial tide, with moon at perigee and favorable winds, reach a height of 30 to 50 feet, advancing as a wall of water or series of waves (6).

Thus the astronomic tide, a gradual rise of 2 to 3 feet in the open oceans, is transformed by contact with the coasts and in some situations comes as a wall of water. Its range in certain localities is greatly magnified. The characteristics of this rise and fall of the water are as varied as the contours of the coast lines and the slopes of the ocean beds.

The rise of water with the cyclone is likewise relatively small in the open ocean. Cline (1) estimates it as less than 5 feet in the greatest storms. Certainly that due to reduction of atmospheric pressure is not more than 2 or 3 feet. There are near the center of the cyclone tremendous seas, described by many mariners as rising 30 to 40 feet, not like waves, but huge pyramids of water. The level of the ocean itself, however, is raised relatively little. As the storm tide encounters the shallows and indentations of the coast, it is retarded and the water rises in many instances 10 to 15 feet and probably in exceptional cases considerably more.

It is the object of this paper to discuss a number of inundations attending cyclones and to show that the rise of water exhibits many if not all of the characteristics of the astronomic tide in like situations, including bores and similar phenomena, and that the direction of movement of the cyclone with reference to the coast line, the contour of the coast, and rate of the cyclone's approach and passage are in certain instances responsible for great storm waves that have destroyed hundred of millions of dollars worth of property and hundreds of thousands of lives in the aggregate.

The need of such a study is remarked by Cline, who says: "Concrete information regarding the winds in hurricanes that produce the swells and tides is limited and, therefore, these are subjects that must be investigated in this connection." He does not consider the currents set up by the storm circulation except to note their existence in citing the drift of gas and whistling buoys. We know that the most powerful agent for transferring quantities of water from one place to another is the current, and strong evidence will be presented to show that the currents about the cyclone are sufficient to explain the storm wave.

Aside from wave motion imparted to the ocean surface, the cyclone has three important effects:

(*a*) The winds of the right rear quadrant of the cyclone, in the Northern Hemisphere, with a counterclockwise rotation, are combined with the movement of translation and are the most powerful and of the greatest duration of any of the winds of the cyclone. The contrast of the strength of these winds with those in the other quadrants is probably even greater than indicated by Cline, because his observations are not instantaneous. The data he has assembled are from land stations. As the cyclone moves inland, it loses intensity. Before the winds of the right rear quadrant reach the observing station the cyclone has weakened and these winds are then less powerful than they were at the time the front of the cyclone was passing over the station.

(*b*) The waters are raised by the winds and elevated by the reduction of atmospheric pressure near the center of the cyclone and form a whirling disk or mound which is redeveloped continually as the cyclone moves forward.

(*c*) As a vast whirlwind of great power, the cyclone communicates to the waters a turning movement which is quite pronounced near the storm center. As proof of the power of these currents, Cline cites the fact that two gas and whistling buoys in August, 1915, and three in September, 1919, were carried 2 to 8 miles parallel to the coast. He states that Trinity Shoals gas and whistling buoy, weighing 21,000 pounds, anchored in 42 feet of water with 6,500-pound sinker, and 252 feet of anchor chain weighing 3,520 pounds, was carried 8 to 10 miles westward.

These currents scour away the sand from the coast in great quantities. In 1900, at Galveston, the waterfront moved in several blocks permanently due to the scouring action of the cyclone currents. Where street cars once ran along the beach, the site of the tracks is now well out in the Gulf. These currents moved from northeast to southwest or from right to left across the front of the cyclone. After the cyclone moves inland a reverse current is set up from southwest to northeast along Galveston Island.

There have been several instances of persons clinging to floating wreckage and being carried, after the center of the storm had passed inland, many miles from southwest to northeast along the coast.

Eliot (3) discusses these currents in connection with cyclones in the Bay of Bengal and notes a strong westerly set at the head of the bay characteristic of storms in this position and indicative of storm formation or approach toward the north end of the bay. The excessive drift noted in many instances by Eliot, Piddington (4), and others from the logs of vessels in cylcones is sufficient proof in itself of strong currents about the center of the cyclone.

The fact that the speed of translation of a cyclone is relatively small and its winds violent are evidence that a strong circulatory motion of the waters must be set up.

Fig. 10.—Precipitation for April, 1927

The very clear evidence that such a current does actually exist makes it all the more remarkable that no one has considered the effect of an obstruction to this flow of water.

When any headland or bay shore is so situated as to impede the progress of this current from right to left in advance of the cyclone, the waters pile up against the obstruction and accumulate in bays and inlets facing into the current either directly or at an angle.

As the center of the cyclone approaches the coast, the whirling motion of the waters become more vigorous with more violent winds. The resistance of shallows near the coast causes the waters in this rotating disk to pile up on the right side of the center of the storm just before it moves inland. All the waters to the left of the center are now carried around the rear of the center and piled up to the right. The tide falls with great rapidity to the left of the center because the return branch of the current in front of the center which has supplied water to the left is now hindered by the shore and shoals.

If there is a bay or inlet to the right of the track of the cyclone center, the waters of this revolving mound are precipitated toward the mouth of the bay or inlet. At that point waters are already accumulated from hours of resistance to the right-to-left current prior to the arrival of the center.

The center of the storm now moves inland, leaving the accumulated waters to be driven by the powerful winds to the rear of the center against the accumulated water at the entrance of the bay, inlet, or river mouth and a storm wave results, driven forward by the most powerful winds of the hurricane.

With a gently sloping bed, this wave is retarded and piled up by resistance. In some favorable cases it takes the form of a wall of water that sweeps everything before it. It is important to note that the displacement of this central mass of water to the right takes place before the storm center moves inland and at the time shoal water is reached. Therefore this pitching of the central mass to the right and its movement with the rear winds can take place in time for the rising waters to be caught in the shift of wind to southeast and south and thus go forward to the right of the center.

The evidences that this action takes place are practically unquestioned, once we have realized the power of this current.

In September, 1900, the cyclone moved to the west of Galveston Bay, the center passing to the left of the city shortly after 8 p. m.

Quoting from the report of Dr. I. M. Cline:

> The water rose at a steady rate from 3 p. m. until about 7.30 p. m., when there was a sudden rise of about 4 feet in as many seconds. I was standing at my front door, which was partly open, watching the water which was flowing with great rapidity from east to west. The water at this time was about 8 inches deep in my residence, and the sudden rise of 4 feet brought it above my waist before I could change my position.

He notes the rapid current from east/west or from right to left in front of the cyclone. The center was then sweeping over a rising Gulf bed to the southwestward and the shore line was rapidly cutting off the return current in front. His residence was located at Twenty-fifth and Q Streets, several blocks from what was then the shore line, and many buildings stood between his residence and the open water. This wave penetrated this section of the city. It was undoubtedly the front of the storm wave. Approximately 6,000 persons lost their lives as this wave advanced.

To produce a storm wave of this kind, the cyclone must move in a direction nearly normal to the coast line. Thus its rotary currents are developed to maximum strength when the storm strikes the shallows near the coast. The wave is then best developed when a headland, island, or other obstruction arrests the rotary movement and there is a bay or inlet to the right for development of the wave.

The highest tides on the coast of the Gulf of Mexico have been developed under such circumstances.

At Corpus Christi, in 1919, the storm center passed to the left of the bay, and the waters reached a height of 16 feet on the left bay shore. The storm moved nearly normally to the coast line.

At Indianola, in 1886, the cyclone moved to the left of Matagorda Bay, in a direction nearly normal to the coast line, and the city was swept away. It was located on the left side of the bay, considered from the point of approach of the storm. The city has never been rebuilt.

At Galveston in 1900 and 1915 the high water was produced by storms moving to the left of Galveston Bay. Galveston is located to the left of the bay entrance and on the northeast end of the island.

In 1915 a severe storm moved inland over southern Louisiana, in a direction nearly normal to the coast line, and the highest tides of record were measured in the left end of the sounds to the right of the Mississippi Delta, and to the right of the storm center.

In July, 1916, the cyclone moved inland to the left of Mobile Bay, nearly normal to the coast line; and Mobile, at the upper end of the bay and to the left, had the highest tide of record, 11.6 feet.

At Tampa, in October, 1921, a cyclone recurved in the eastern Gulf and passed to the left, nearly normal to the coast line. The waters in Tampa Bay, which had been at normal height, rose to 10.5 feet above low water, by far the highest of record.

The tracks of these storms are shown in Figure 1.

The Corpus Christi storm of 1919, the Galveston storm of 1900, and the Louisiana storm of 1915 crossed very closely to the same point, approximately 27 north and 89½ west. One was moving westward, another west-northwestward, and the third northwestward. The tide at Burrwood was between 2 and 3 feet approximately in each instance, evidently somewhat higher in the case of the storm that moved northwestward. However, the water was then banking up on the right of headlands which interfered with the flow from right to left about the center. At 8 a. m. of September 29, 1915, there was a tide of 3.7 feet at Burrwood and at Mobile 2.5 feet. This difference was consistent as the storm approached and the water was not so high to the left of Burrwood, showing that the right-to-left flow was being hindered and the water piled up as it passed around the Mississippi Delta.

Practically all of these tide records show the water piling up to the right of obstructions to its flow. These are separate and distinct effects from that caused by the drive of water from the right rear quadrant of the cyclone described by Cline.

In the Bay of Bengal the conditions along shore are more favorable for tidal waves, especially at the head of the bay. The cyclones are perhaps as a rule more intense than West India hurricanes. The astronomical tide is developed to a much greater extent than in the Gulf of Mexico.

These conditions combine to produce more severe storm waves in India, especially when the time of high water approximately coincides with the arrival of the

storm wave. On the coasts of India the storm wave frequently arrives as a sudden rise of water, sometimes as an advancing wall and sometimes as a bore. The only authentic case of record of a bore produced from a West India hurricane was in September, 1926, at Miami. There the highest water occurred with the shift of wind, and in the Miami River the tide came in the form of a bore that left a mass of wreckage from boats that had sought safe anchorage.

Eliot cites several great cyclones in the Bay of Bengal, some of which were attended by pronounced storm waves. The movement of the storm, the shape of the coast line, and other conditions were practically the same as that shown in the case of record water heights in the Gulf of Mexico.

The Calcutta cyclone of 1864.—It crossed the coast line moving in a direction nearly at right angles to the coast, near Contai, to the left of the mouth of the Hooghly. The barometer fell to 28.025 inches and the calm lasted at Contai from 9:45 to 11:00 a. m. The storm wave arrived at the mouth of the Hooghly a little after 10 a. m., high water being due at about noon as the moon was nearly full.

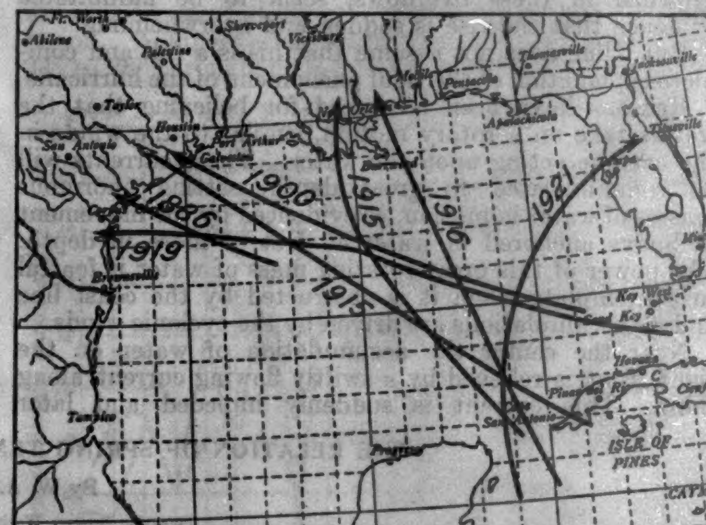
There was an enormous accumulation of water at the northwest angle of the bay, the left side. In the case of a storm there is for some time, as the storm center approaches so as to give a storm wave, a large accumulation of water, according to Eliot, and this head of water finally gives rise to a sudden and overpowering advance of the accumulated mass of water up the river and an almost equally rapid inundation of the lowlands near the seashore. The storm wave is estimated to have risen 40 feet in the Calcutta cyclone. The loss of life from drowning was estimated at 50,000 and from disease as a result of the storm, 30,000. Eliot recites the account of an eyewitness, to the effect that the natives on the coast, whence he was traveling toward Midnapore, informed him that a high bore was to be expected at half past 12. "The water," his informant relates, "all at once suddenly rose as if by magic and steadily rolled towards us."

The Backergunge cyclone of 1876.—The center moved across the bay toward the northeast, passing to the left of Chittagong, and near Bakergunge on the left shore. An enormous storm wave was driven over the islands and lowlands near the mouth of the Megna. There was an unusually high tide, followed very shortly by the storm wave. The pressure of the advancing wave prevented the tidal and river water from flowing off. The storm wave was retarded and finally overpowered the downflowing waters and rushed with irresistible force over the islands and low-lying coastal areas covering them to a depth from 10 to 30 or 40 feet. It was estimated that 100,000 lives were lost from drowning and subsequently 100,000 more died of disease as a result of the inundation. The exact time of the passage of the center of the cyclone and the beginning of the storm wave are not given. Both occurred shortly after midnight with a spring tide.

The False Point cyclone of 1885.—The center passed over False Point Lighthouse, the barometer falling to 27.135 inches. The reading was taken by a trained observer at a land observatory with a properly verified barometer. The wind at the lighthouse at 6:30 a. m. hauled from northeast to northwest, continued to blow a hurricane for a few minutes, then suddenly lulled. The calm lasted till 6:50 a. m., when the wind came with redoubled fury from the south-southwest. The storm wave came up at 6:20 a. m. and swept over False Point harbor, destroying all the houses ashore. It rolled in a wide unbroken wave in a northeasterly direction, submerging villages and carrying away before it, with irresistible force, houses, cattle, human beings, etc. The measured height of the wave at False Point was 22 feet.

Piddington (4) gives descriptions of inundations that have visited Coringa on the Coromandel coast of India. Coringa is located to the right of the delta of the Godavery River. According to these accounts, in December, 1789, during a cyclone, when the high tide was at its highest point and the northwest wind, blowing with fury, accumulated the waters at the head of the bay, the unfortunate inhabitants saw with terror three monstrous waves coming in from the sea. The first, sweeping everything in its passage, brought several feet of water into the town. The second inundated all the low country and the third overwhelmed everything.

In 1839 more than 20,000 persons are said to have perished at Coringa in a storm wave.



Partial tracks of 7 tropical cyclones that created record storm tides on the coast of the Gulf of Mexico. All moved so as to approach the coast approximately at right angles. Record tides were produced in bays and inlets immediately to the right of the point where the center crossed the coast

A number of these inundations have occurred on the low coastal lands of China. One in 1881, at Haifong, in a typhoon, caused the death of 300,000 persons.

As an illustration of the power of the cyclone in driving water around the center: In October, 1910, a cyclone described a loop in the eastern Gulf and finally passed out over southern Florida on the 18th. On that day the tide fell to 9 feet below mean low in the Hillsboro River at Tampa, while on the right of the center, south of Cape Romano, the keys and islands were swept by great waves from the Gulf that reached a great distance inland. The survivors escaped by climbing trees. (5)

The above accounts seem to bear out the statement that the rise of water in the storm inundation is by no means gradual. In many cases the direction of movement of the cyclone, the shape of the coast line, the occurrence of normal high tide at time of inundation, from astronomical causes, and other influences, combine to produce a sudden rise of water which sweeps forward like a great wave and causes immense destruction and great loss of life.

CONCLUSIONS

If the rise of water to the right of the center of a cyclone, on moving inland, is due solely to the driving forward of the winds of the right rear quadrant of the cyclone, there remains no satisfactory explanation of the sudden rise of waters to the right of the center. These winds to

the right of the center do not change abruptly either in speed or direction, and even the sudden shift of wind to the opposite or nearly opposite quarter as the center passes will not account for the suddenness of the rise in many cases. It is difficult to understand how this wind, even though in a sudden and violent onslaught, such as occurs in the cyclone, can in so brief a space drive forward such a mass of water. The storm wave sometimes precedes the shift of wind at the rear of the center, and with this explanation it must be assumed that the wave outruns the wind which produces it.

Cline then assumes that the rise is gradual and that there is no "storm wave" or "tidal wave." Clearly, his explanation of the tide, if accepted as offering the only causes of high water, do not include the causes of a storm wave. Yet the testimony of observers and the fact that hundreds of thousands of persons have been drowned in these overflows, seem to be indubitable evidence that the rise is sudden and overwhelming.

But Cline does not assume that his is a full and complete explanation of the tidal phenomena of the hurricane.

Reasons have been advanced for believing that the waters take on a rotary motion, similar to the winds in the cyclone acting upon the water. These currents will be communicated to great depth, setting enormous masses of water in motion, as evidenced by the movement of buoys anchored in water 40 feet or more in depth. The power of this great rotating mass of water is fearful to contemplate when it is obstructed by the coast line and its accumulations are driven by the cyclonic winds.

Near the center the accumulation of water on the right front is relieved by a swiftly flowing current along shore. This current is suddenly impeded and later reversed as the center of the cyclone moves inland and the rear winds come upon it. With great pressure suddenly thrown against this relieving current as the center leaves the rotating mass, there is cause for a more rapid accumulation on the right of the center. All the waters of the rotary disk tend to pile up on the right of the center against the coast line. Far from the center this is a slow process, but near the center, the shorter the diameter of the whirl and the greater the velocity of the current the more sudden and violent will be the onslaught.

When a bay, inlet, or river mouth lies immediately to the right of the point where the cyclone crosses the coast, this mass of water drives forward into the sloping bed and narrowing channel, to be retarded and heaped up. It finally spills over and sweeps forward. These places are frequently harbors for ships and the locations of cities with a considerable population.

ACKNOWLEDGMENT

The author claims nothing original in the way of observation. He has consulted the writings and observations of Weather Bureau officials recorded mostly in the MONTHLY WEATHER REVIEW and numerous additional sources, but chiefly the works of Cline, Eliot, and Piddington.

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THE RELATION OF SPRING TEMPERATURES TO APPLE YIELDS

By W. A. MATTICE

[Weather Bureau, Washington, October 26, 1927]

Apples, while not of such universal need as corn, wheat, and other important food crops, are still of sufficient value to the human race to have rather large areas of certain States devoted to their cultivation. By examining a dot map prepared by the United States Department of Agriculture, it will be found that the heaviest centers of apple production lie in two States, New York and Washington. No other State has the concentration that is found in these, and between them they produce a large proportion of the Nation's apple supply.

The cultivation of apples requires somewhat different conditions of soil, climate, etc., than most crops. While different varieties of apples require longer or shorter growing seasons, in most cases the local conditions or topography must be favorable if a high-producing orchard is to be maintained. One of the most important risks that confront the apple grower is the liability of damage from late spring frosts. Most apple-producing areas of the United States are exposed to this injury and serious losses occur, but the frost hazard in some sections is comparatively small, particularly in the Northeast. Fruit trees respond readily to relatively short periods of warm weather in spring, and when there are rather long periods of warmth, premature blooming is practically certain. In cases of this kind, the late frosts cause greater damage than when the trees are in a less advanced stage, even though the temperatures may be lower in the latter case.

It has long been well known that the location of an orchard is a vital factor in determining its success. A north slope in some cases has been found to be slightly more favorable than other exposures, due to the retarding effect on blooming and thus reducing the liability of damage by frosts. Orchards in pockets are exposed to harm through air drainage, which will often cause extensive injury to bloom or newly set fruit, while a neighboring orchard on a higher elevation may not be harmed. Spring frosts, the amount of precipitation, the summer temperatures, etc., are elements over which the orchardist has no control, but weather influences can often be controlled or modified through improved orchard management.

The inland river valleys of Washington are peculiarly adapted for apple culture, with their comparatively mild climate and long summers. The southern shore of Lake Ontario in New York State is another region which has been largely devoted to the cultivation of deciduous fruits, with the great body of water acting as a deterrent for spring frosts and otherwise moderating the climate. In other States, Virginia and West Virginia are probably the only ones showing such a concentration of fruit orchards, with the Shenandoah Valley famous for its orchards, and especially for the apple-blossom festival which takes place there every year. Conditions in Virginia, again, are such as to promote apple growing on a large scale, with the great valley affording an extensive area sheltered from many climatic severities.

During the summer of 1926 a survey of the apple-producing sections of Virginia, West Virginia, and Pennsylvania was made by the several State experiment stations and the Department of Agriculture with the coop-

eration of the Division of Agricultural Meteorology of the Weather Bureau. The purpose of this survey was to determine the economic, geographic, and climatic effects on the apple industry of these three States, and the results show some interesting relations of temperature to the yields of apples.

In the survey, data were obtained for Martinsburg, W. Va., giving the dates of bloom of the York Imperial apple, and also the per cent of a full crop for the years 1911 to 1926. With this material an effort was made to find the day-degree temperature constant for apple blooming at that place. Temperature records are kept at the cooperative Weather Bureau station, and these were used in the study.

In accord with the well-known practice of accumulating temperatures above 43°, various periods of time were chosen, such as January 1 to bloom, February 1 to bloom, and from the blooming date of the previous year to bloom of the next. The accumulations found by these methods were unsatisfactory in that no close relation could be found between the constants, each period having large variations from year to year, as well as from the high to low values, the difference in the latter case sometimes reaching as high as 25 per cent of the maximum accumulation. These results seem in accord with previous findings, as various writers have found objections to the day-degree method. Livingston (1) offered a system of indices based on Lehenbauer's observations of the growth of maize seedlings, but, as these indices are based on an optimum temperature for best growth, more detailed data are needed than were available. It would appear from these studies and from others made by various investigators that the day-degree temperature constant is unreliable, at least when we continue to use the temperature data as usually recorded. Seeley (2) has proposed a widely different method of exposure of the thermometers than usually prevails, and it would seem, in view of all the diverse results obtained, that some other thermal value is necessary to properly obtain plant temperatures. It must be that plant temperatures are the determining factor in growth, for all the work done on constants, using shelter exposed thermometers, is at least variable, as far as obtaining a constant comparable with growth is concerned. It may be that special thermometers will have to be devised, or radical changes made in present methods of exposure, before data showing a constant relation between temperature and periods of plant growth can be found.

There is a close relation between spring temperatures and variations of the blooming date, as warm weather at this season hastens blooming and cooler weather retards it. Records previously obtained had shown a very close relation between the weather during spring and blooming. At Wauseon, Ohio, the period most effective in controlling blooming was found to be March 21 to April 30, but in Virginia the period for which spring temperatures were found to be most effective was from February 7 to March 28. This, however, is in accord with expectations, as the season in Virginia is earlier.

The correlation coefficient between the temperature for this period and yield for Virginia was -0.79 ± 0.05, a very high coefficient for the data used. The yields were those for the whole State, and the temperatures were computed from stations in the great valley and the southwest, where the bulk of the crop is grown.

The relation between apple yields and spring temperatures was so pronounced in Virginia as a whole that the same period was applied to the Martinsburg figures. The result was very gratifying for the coefficient of correlation was -0.85 ± 0.04 against -0.79 ± 0.05 for the whole State.

The influence of the weather during the week of blooming was also studied in an attempt to correlate various elements with yield. In this study, for which Martinsburg blooming dates were used, the results were disappointing. The only element exhibiting a relation to yield was minimum temperature, and even that was too small to be of much significance.

The year 1921 will long be remembered in the apple region of Virginia, for in that year the yield was reduced tremendously. The spring was unusually warm and the apple trees bloomed early, the earliest during the period considered, and while they were in full bloom there was a severe freeze, largely reducing the yield. Full bloom was reported that year about April 10, and freezing weather occurred at almost the same date over the entire region. Temperatures during this cold spell ranged from 23° to 28° throughout the great valley, and the crop was

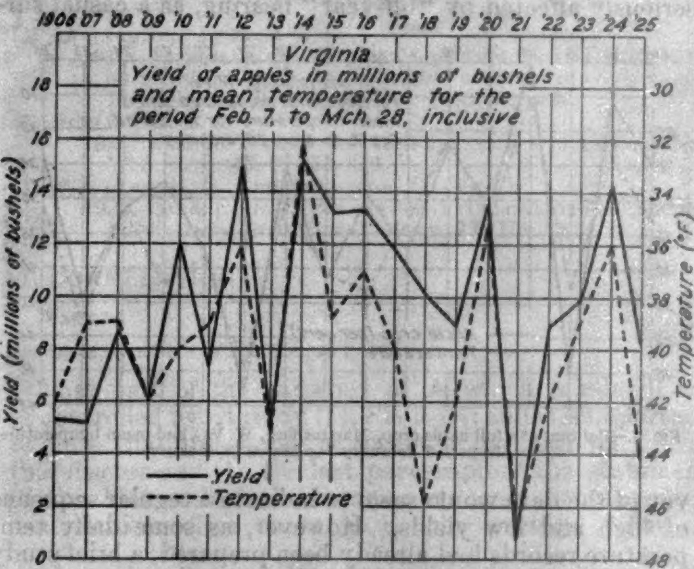

FIG. 1.—Yields of apples, Virginia, in millions of bushels and mean temperature for the period February 7 to March 28, inclusive

only 0.6 million bushels, or more than 94 per cent less than an average yield.

The spring of 1926, on the other hand, was characterized by moderately cool weather, which held the blossoms in check until May 5, or over a week later than the last killing frost. The season from blooming until harvest was also favorable, and the weather during the setting of the fruit must have been, for the estimated total production was 19.9 million bushels. This large yield, which was by far the largest of record, was the result of the cool spring and the favorable conditions until harvest.

The relation between spring temperatures and yields in this region is shown graphically on Figure 1, which is based on the total production of apples in millions of bushels from 1906 through 1925, and the spring temperatures. It will be seen that a very close relation is shown after 1911, which seems to be the boundary of "off-year" bearing. Figure 2 gives the same data for Martinsburg, W. Va., except that the yields are given in per cent of a full apple crop.

In connection with "off-year" bearing, there is a tendency of certain varieties of apples to vary their yield from year to year in such a way that a year of small yield is followed by one of larger yield, then a small

yield, etc. These terms are purely relative, of course, and the smaller yield for any one year may be rather large, as compared with the average. In cases of this kind it is extremely difficult to compare apple yields with the weather as it is well known that the weather does not fluctuate in any such simple way as this. The restriction of a community to one variety, or a few varieties that have the same tendency to "off-year" bearing will cause large variations in the yield with no cause other than that inherent in the tree itself. A careful choosing of varieties of apples will largely avoid this and, as a community either discards one variety and chooses another, or new orchards come into bearing, the yields will tend to smooth themselves without great variation. Something of this kind must have occurred in Virginia, for in 1911 a marked change occurred in the total production of apples, with the yields thereafter exhibiting no apparent tendency to "off-year" bearing; the variation may be there, but so obscured by other variations as to be inobservable.

Apple production in New York State apparently was seriously affected by "off-year" bearing, as a casual survey of the data would seem to indicate a regular sequence of high and low yields. However, as some daily temperature records had already been prepared, a brief study was begun in order to determine whether or not there was any relation between yields and spring temperatures. The preliminary correlations were rather inclined to bear out the theory that any relation that might exist was obscured by "off-year" fluctuations, but as the survey enlarged, the coefficients began to be more and more significant until a conclusion could be reached that spring temperatures were of importance there also.

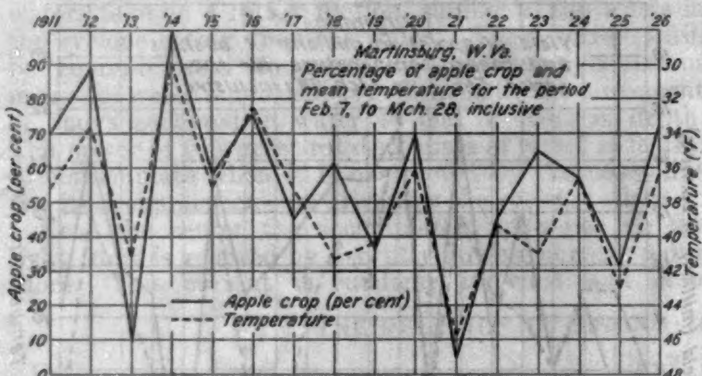

FIG. 2.—Per cent of a full apple crop, Martinsburg, W. Va., and mean temperature for the period February 7 to March 28, inclusive

The data were prepared in the same manner as for Virginia, with 10 representative stations chosen throughout the fruit belt. There was, of course, some breaks in the records of the cooperative stations, but in each instance another station was taken as nearly typical of the missing one as possible. Daily temperature records were thus obtained for the 25-year period from 1901 to 1925, inclusive, and weekly mean temperatures prepared from them.

The series of correlations extended from March 1 to June 28, inclusive, and Table 1 shows the results of these. It will be noted that the temperature effect on apples in New York State is somewhat more complex than in Virginia, as there are three distinct periods of maximum importance.

TABLE 1.—*Coefficients of correlation of weekly mean temperatures with apple yields*

Beginning with—	Number of weeks						
	1	2	3	4	5	6	7
Mar. 1	−0.12	−0.22	−0.11	−0.14	−0.15	−0.19	−0.22
Mar. 8	−.18	−.08	−.13	−.14	−.20	−.22	−.29
Mar. 15	.18	−.08	−.10	−.17	−.19	−.20	−.30
Mar. 22	−.17	−.10	−.24	−.29	−.37	−.30	−.29
Mar. 29	−.09	−.25	−.28	−.38	−.36	−.24	−.16
Apr. 5	−.24	−.27	−.39	−.35	−.23	−.16	.04
Apr. 12	−.19	−.36	−.31	−.17	−.06	.14	.27
Apr. 19	−.38	−.28	−.11	.01	.22	.35	
Apr. 26	−.11	.08	.19	.35	.44		
May 3	.19	.31	.49	.52			
May 10	.25	.44	.52				
May 17	.45	.58	.50	.44	.30	.16	
May 24	.48	.41	.35	.16	−.02		
May 31	.12	.14	−.10	−.29			
June 7	.13	−.26	−.45				
June 14	−.51	−.50					
June 21	−.44						

Beginning with—	Number of weeks—Continued					
	8	9	10	11	12	13
Mar. 1	−0.27	−0.29	−0.23	−0.18	−0.08	0.01
Mar. 8	−.29	−.24	−.17	−.07	.03	
Mar. 15	−.26	−.17	−.03	.08		
Mar. 22	−.21	−.06	.00			
Mar. 29	.01	.14				
Apr. 5	.17					

The coefficients for all the early periods are small, but gradually grow larger and reach a maximum value of −0.39 for the three weeks from April 5 to April 25. The sign of the coefficient then gradually changes to positive and the values again slowly approach a maximum until the highest, +0.58, is reached for the two weeks from May 17 to May 30. The sign then changes to minus and approaches another maximum value of −0.59 for the two weeks from June 14 to June 28. This division into three distinct periods of the temperature effect is rather interesting. The last period probably coincides with that of the usual June drop; the intermediate period probably falls during the blooming time, the early period apparently has no visible phenomena in connection with it, but it may be that this is the period which coincides, or rather is comparable, with the important period in Virginia.

The coefficients of these three periods were not, in themselves, sufficiently important to justify drawing exact conclusions from them as regards the effectiveness of spring temperatures in controlling apple yields.

As the periods indicated did not overlap, temperature correlations between themselves should be comparatively small. This was found to be true, so a multiple correlation was made following the method outlined by Wallace (3). The three variables combined in this form of a correlation gave a coefficient of 0.81, which can be interpreted to mean a very high degree of relationship between the three variables and apple yields.

The equation necessary for computation of the yields was found to be: $X = -0.490A + 0.382B - 0.605C + 49.91$.

The yields computed from this equation were found to be rather accurate, on the whole, and much closer than could be obtained from the average yield. The values of the computed and actual yields follow:

Computed and actual yields of apples in New York State

[Yields in millions of barrels]

Year	Computed yield	Actual yield	Difference
1901	6.0	3.7	2.3
1902	12.1	13.7	1.6
1903	16.2	15.3	0.9
1904	12.0	18.3	6.3
1905	8.5	7.0	1.5
1906	9.9	10.3	0.4
1907	8.3	9.3	1.0
1908	11.6	11.0	0.6
1909	7.5	8.5	1.0
1910	5.7	5.7	0.0
1911	14.6	13.0	1.6
1912	11.6	14.7	3.1
1913	6.8	6.5	0.3
1914	15.0	16.5	1.5
1915	6.6	8.5	1.9
1916	12.0	11.8	0.2
1917	11.0	5.4	5.6
1918	17.2	13.6	3.6
1919	6.7	4.8	1.9
1920	14.1	15.7	1.6
1921	6.3	4.5	1.8
1922	10.8	12.0	1.2
1923	8.0	8.3	0.3
1924	8.1	7.3	0.8
1925	7.9	10.8	2.9
Average	10.2	10.2	1.8

It will be seen that there are several instances where the computed yields show large deviations from the true yield, but these are not as large as their deviation from the average yield. The standard deviation of yield is 4.05 million barrels and that of actual from computed is 2.33 million barrels, or a reduction of 42.5 per cent.

SUMMARY

The data on hand are, of course, rather limited and can not take into account all possible influences on yield. It was planned originally to demonstrate that apple yields were largely affected by spring temperatures and this seems to be proven beyond a reasonable doubt.

There are, of course, other factors which influence yield, but in a study of this type for an entire State they are too varied to be included and an attempt to combine all possible influences, if known, would necessarily be tremendously bulky and take an amount of time entirely out of comparison with the results obtained.

Single orchards, if complete data could be obtained, would produce results of more significance than those for a whole State. The State data must necessarily be less complete and more difficult of access even when there are more or less detailed reports. Using the data before mentioned the results are very satisfactory in that they conclusively demonstrate that the one factor of major importance is spring temperatures.

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ON THE MEASURE OF CORRELATION

By GILBERT T. WALKER

[Imperial College of Science and Technology, South Kensington, London, S. W. 7, November 1, 1927]

There has of late been a welcome recognition of the services that can be rendered to meteorology by statistical methods; but associated with some of the recent theoretical discussion there have been elements which appear to me unsound and I would ask permission to make some remarks on a theorem which is attributed to W. H. Dines.

1. The authoritative enunciation of the theorem is that contained in the Meteorological Magazine.[1]

"If there is a cause A and a result M with a correlation r between them, then in the long run A is responsible for r^2 of the variation of M."

On the other hand, working in India in regrettable ignorance of the classical literature of the subject, I was led to develop the ordinary regression equations from a definition of the correlation coefficient between two quantities as "the proportionate extent to which the variations of each are determined by, or related to, those of the other."[2]

2. It might at first sight appear that so fundamental a discrepancy must rest on a wide difference of terminology; but this can scarcely be the case. If the departures of M and of A are denoted by x_0 and x_1, and their standard deviations or "square-means" by σ_0 and σ_1, we may denote x_0/σ_0 and x_1/σ_1, "the proportional departures," by z_0 and z_1.

Then the ordinary regression equation is

$$x_0 = \frac{r\sigma_0}{\sigma_1} x_1 + b$$

where b is independent of x_1, or $z_0 = rz_1 + d$, where d is independent of z_1.

That part of the variation of M which is related to, or controlled by, A is, by (1), $r\ \sigma_0\ x_1/\sigma_1$; and it is important to note that this value is accepted by both parties in this discussion. In the last paragraph of the statement of the Meteorological Magazine we read "the average contribution of a to m, i. e., the average value of $r\sigma_m \left[r \frac{m}{\sigma_m} + y \right]$"; and, by equation (7) there, this is equal to $r\sigma_m \left[\frac{a}{\sigma_m} \right]$; in our notation this is $r\sigma_0 \frac{x_1}{\sigma_1}$, which bears to σ_0 the ratio rz_1. We may note that this interpretation is also accepted by Krichewsky,[3] who writes in his (6a) the regression equation for two variables as $z_0 = \beta_{01} z_1$ and replaces this in his (11) by $z_0 = r_{01}\beta_{01} z_1$. He then defines E_{01} as "that part of the variation of z_0 for which the variable z_1 is responsible in the long run . . ." and takes E_{01} as $r_{01}\beta_{01}$.

Now, as stated below, I do not agree with the substitution of $\beta_{01} z_0$ for z_1, but the fact remains that Krichewsky regards something equal to $\beta_{01} z_1$ as the part for which z_1 is responsible.

3. Now x_1 is a quantity obeying the same error law of distribution as x_0, its standard derivation being σ_1 corresponding to σ_0 for x_0; so just as the values of z_0 obey the error law of distribution and have a standard deviation of unity, the values of rz_1 will obey the error law and have a standard deviation of r. To say that in the long run these values of rz_1 are r^2 times those of z_0 appears to me definitely because mathematically, incorrect. It must

[1] February, 1921, p. 21.

[2] Indian Meteorological Memoirs, Vol. xx, Pt. 6, p. 120, 1909.

[3] "Interpretation of correlation coefficients." Physical Dept. Paper No. 22, Cairo, 1927.

be admitted as conceivable that on general grounds a man may prefer to estimate the figure of merit of a correlation as measured by r^2 and not by r; but this does not give him the right to say that if the terms of one group of figures are r times those of another, the ratio of one group to the other is r^2.

4. The error creeps in when Krichewsky replaces z_1 by $\beta_{01}z_0$ or rz_0; for when forecasting it is z_1 that is given and the estimated value of z_0 is z_0+e, the error being independent of z_1. But the mean value of z_1 would be rz_0 if we were forecasting z_0 from z_1 by an equation $z_1=rz_0+f$, and the error f in that forecast would be independent of z_0, which is quite a different matter. If it were legitimate to replace a quantity by its mean value under different conditions we could apparently carry the process further and derive the impossible equation $z_0=rz_1=r^2z_0=r^3z=r^4z_0= \ .$

But if we replace z_1 by rz_0+f, to which it is equal, and note that the standard deviation of f is $(1-r^2)^{1/2}$, we see that the standard deviation of $r\ (rz_0+f)$ is r times the standard deviation of $(r^2z^2_0+f^2)^{1/2}$, or $r\ (r^2+1-r^2)^{1/2}$, which is r not r^2.

A further point is that the proof of the r law just given holds whether or not there are other factors not independent of z_1.

5. The only argument with which I am acquainted for wishing to estimate relationships by r^2 rather than r is that if a quantity were controlled by two independent factors the total relationship would then be got by adding the component relationships. To this the reply is that in meteorology independence is the exception not the rule. If pairs of forces acting on a particle were always at right angles it might in the same way be urged that the effect of a force should be estimated by its square in order that the resultant might be estimated by the sum of the forces. Now, in estimating the value of a method of forecasting the proportion to which the forecast is controlled by the known data is in my opinion the vital feature, and I should not regard it as more justifiable to adopt r^2 rather than r because it would have points of convenience in exceptional cases than I should to measure forces by the squares of their present measures for a similar exceptional convenience.

NOTE ON THE THEOREMS OF DINES AND WALKER

By Edgar W. Woolard

Let x_0, x_1, be the departures of any two varying quantities; and let the (unknown) complete and exact functional relation in which they are involved be

$$F(x_0, x_1, x_2, \ . \ . \ . \ . \ . \ . \ . \ )=0, \tag{1}$$

in which F may be of any form, and in which the x_i may be mutually dependent in any manner, or in part mutually independent.

From a number of pairs of corresponding observed values, we may always compute σ_0, σ_1, and r. Furthermore, for any individual pair we can always write

$$\frac{x_0}{\sigma_0}=r\frac{x_1}{\sigma_1}+b, \tag{2}$$

because a value can always be assigned to b so that this equality will be satisfied; similarly we can always write

$$\frac{x_1}{\sigma_1}=r\frac{x_0}{\sigma_0}+b'. \tag{3}$$

Also, for any *given fixed* value of x_1, we can always find B such that

$$\frac{\bar{x}_0}{\sigma_0}=r\frac{(x_1)}{\sigma_1}+B, \tag{4}$$

and for any *given fixed* x_0 we can find B' such that

$$\frac{\bar{x}_1}{\sigma_1}=r\frac{(x_0)}{\sigma_0}+B', \tag{5}$$

in which $\bar{x}_0$, $\bar{x}_1$, are the *means* of the values of one variable associated with a *fixed* value of the other. The curves

$$x_0=r\ \frac{\sigma_0}{\sigma_1}\ x_1,\ x_1=r\ \frac{\sigma_1}{\sigma_0}\ x_0, \tag{6}$$

are the straight lines of "best fit" (in the sense of least squares) to the individual observations and to the means. However, the fit may or may not be close, and in either case there may or may not exist systematic departures from it; b, B, may or may not be independent of x_1, e. g., and certainly will not if x_1 is not independent of x_2, ... The standard deviations of b, b', are each $(1-r^2)^{1/2}$.

The preceding equations do not, by themselves, permit any conclusions whatever to be drawn concerning relations of cause and effect; they apply to mere covariation only.

Sir Gilbert Walker has defined the correlation coefficient r as "the proportionate extent to which the variations of each of two quantities are determined by, or related to, those of the other," whence "if there is a cause A and a result M with a correlation r between them, then in the long run A is responsible for a fraction r of the variations of M." The exact meaning intended to be conveyed by this statement is to be found in the mathematical reasoning by which the theorem is supported:

If, in (2), b *is* independent of x_1, then the part of the variation of x_0 which is controlled by x_1 is $r\ \frac{\sigma_0}{\sigma_1}\ x_1$, and the standard deviation ("square mean") of this controlled part is r times the standard deviation, or mean variation of x_0. From this it appears that Walker adopts the standard deviation as a measure of variation and intends his theorem to state that a fraction $r\sigma_0$ of σ_0 is due to variations in x_1, and the remainder $(1-r)\sigma_0$ to variations in x_2, ... Clearly, this implies not only that x_1 is independent of the remaining variables, but also that x_0 and x_1 are linearly related, so that b is a function only of x_2, ... ; in this case, the first term on the right of the identity

$$\sigma_0^2=r^2\sigma_0^2+(1-r^2)\sigma_0^2 \tag{7}$$

is, by (2), the fraction of σ_0^2 due to x_1.

Now, Dines's theorem states that "if there is a cause A and a result M with a correlation r between them, then in the long run A is responsible for r^2 of the variation in M." Again, the exact meaning intended must be sought in the mathematical proof offered for the theorem:

Substitute (3) in (2):

$$x_0=r\sigma_0\left[r\frac{x_0}{\sigma_0}+b'\right]+b\sigma_0. \tag{8}$$

If b is a function only of x_2, ..., the first term on the right is the contribution from x_1; for any given *fixed* x_0, the *average* of this term is given by (5), and we have

$$(x_0) = r\sigma_0\left[r\frac{(x_0)}{\sigma_0} + B'\right] + b\sigma_0, \tag{9}$$

in which the first term is the contribution due *in the long run* to x_1. *If*, as frequently happens, B' is practically zero, then

$$(x_0) = r^2(x_0) + b\sigma_0, \tag{10}$$

in which the first term on the right is the *average contribution*, from x_1, to the *particular* value (x_0). Apparently, Dines's theorem is, or should be, intended as a statement of (10).

Clearly, the S. D. of (x_0) is not σ_0, which would seem to dispose of Walker's objection to Dines's theorem. Krichewsky has pointed out, moreover, that Dines's theorem may be interpreted to be a statement of equation (7), in which case it becomes identical with Walker's theorem when allowance is made for the fact that Walker adopts the S. D. as a measure of variation, while in (7) the variation is measured by the square of the S. D., or variance. Implicit in the theorem as thus interpreted, however, is the assumption of the independence of x_1 and the other variables; such independence is the exception rather than the rule. By equation (2) we can always divide the variance in the manner shown in (7); and we may regard the theorem of Dines and Walker as always holding for mere *covariation*. Unless x_1 is independent, however, the law does not hold for *cause and effect*. Walker does not seem to recognize the important distinction between these two cases. Krichewsky has attempted to provide a measure of *causal* influence, even when x_1, x_2, ... are mutually dependent.

NOTES AND ABSTRACTS

INFLUENCE OF PRECIPITATION CYCLES OF FORESTRY[1]

The author made an analysis of the annual radial growth rings of trees in northern Idaho. White pine was the species studied. The trees were located in the Priest River watershed of the Kaniksu National Forest and the stumps of recently cut trees were used. In order to have a wide dispersion of age, five age classes were investigated, viz, 280, 230, 180, 140, and 75 year old trees were measured in each of the five groups, 8 to 15 dominent trees being measured in each group.[2]

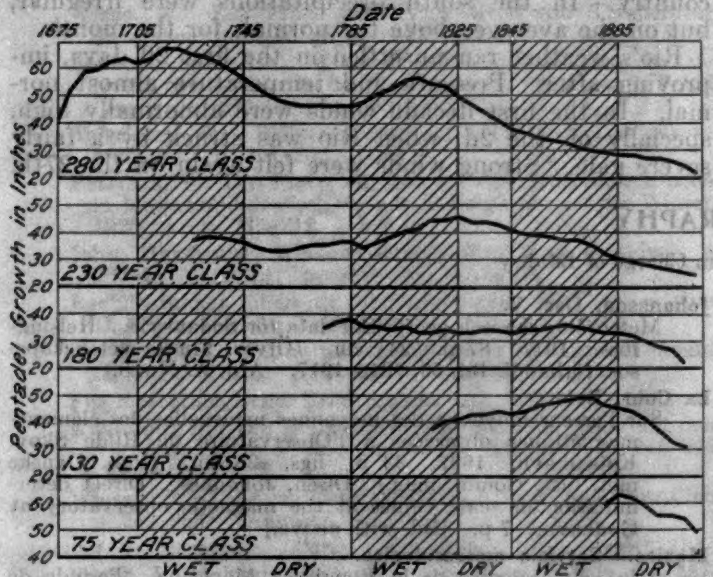

FIG. 1.—White pine growth, 1675–1925

The author plots the 5-year growth for each age class and smoothes the graph so formed by the use of a five-pentad moving mean. By this method general trends are made to stand out much clearer than in the unsmoothed means.

[1] Read by Robert Marshall before the Northern Rocky Mountain Section, Society of American Foresters and printed in Journal of Forestry, Vol. XXV, No. 4, April, 1927.

[2] The author's method of tree-ring measurement as described in a personal letter to the editor was as follows: I first examined each stump and chose some radius which was fairly close to the average in length, showed no growth abnormalities, such as are occasioned by knots, fire scars, insects, or other causes. * * * Along the radius I placed a narrow strip of stout paper and made a small pencil mark along the edge where each ring came. I worked, of course, from the outside to the center of the tree, so that I might date each year's growth. Western white pine is not characterized by double rings, so that difficulty in stem analysis was obviated. In the office I measured the distance between the marks on my strips of paper and thus obtained the width of each growth ring to the nearest hundredth of an inch.

Figure 1 is the smoothed growth curves for each age class of white pine, 1675 to 1925.

The author points out that in every age class from the 280-year-old stand to the youthful 75-year-old stand, which normally should be experiencing its most vigorous increment, there is a rapid decrease in growth during the last 40 years. This is so distinct as to preclude any possibility of chance being the cause. Suppression could not have been responsible because the trees studied were ones which from their size must have been dominants, or in youth even superdominants; therefore, it is held that the only possible solution seems to lie in a deficiency of precipitation.

The 40 years since 1885 have obviously formed an exceedingly dry epoch.

The author further says:

> The evidence bearing upon the score of years between 1825 and 1845 also appears muddled at first sight. The 280-year class shows an exceptionally rapid decline, while the 180-year class reaches the trough of its first 140 years of growth. The 140-year class shows a slow acceleration, but relatively this can be considered a decided drop, for normally the period between 40 and 60 years should show the most rapid growth rate. Only the 230-year class is inconsistent, for it practically maintains its growth peak. Nevertheless, the vote seems to be 3 to 1 that this was a dry period.
>
> Between 1785 and 1825 the 280-year class exhibits a remarkable peak, almost incredible in a stand which was already 140 years old. This certainly indicates an abundance of precipitation in a striking manner, as does the next younger group, which after 50 years of poor growth at the age of 95 started a rapid acceleration which lasted for 35 years. Only the 180-year class causes scientific sorrow, for no 40-year old stand should slump, no matter how slightly, during wet years. But here again the majority should prevail, pending further investigation, and so this 40-year period should be called a wet one on the growth records. * * *
>
> Going back from 140 to 180 years ago, only two age classes remain. Both of these indicate clearly a dry period. The older drops rapidly and then maintains the lowest level of its first 180 years. The younger, just when it should be making its best growth, also reaches the low point of its first 180 years.
>
> In regard to the 40 years before this period, we have only the oldest age class to fall back upon. This reaches a peak, as one would expect for a stand of 60 to 100 years, and we can only surmise from its unusual height, exceeding all other points on any of the curves, that this was due to a wet phase of the cycle coming in conjunction with the most vigorous period of youth.

—*A. J. H.*

WEATHER IN THE AMERICAS AS AFFECTING TRADE

[Cable reviews to Commerce Reports, Nov. 7, 1927]

Argentina, October 29.—Rains throughout the country brought about a brighter commercial outlook during October, and * * *. The sowing of cottonseed is in

full swing and prospects for the new crop have improved considerably as a result of rains which fell during last month throughout the Chaco and Corrientes.

Brazil, October 28.—In Bahia, Consul Howard Donovan reports a state-wide drought, affecting business unfavorably.

Chile, October 27.—The condition of agriculture still appears satisfactory, although the continuance of inclement weather is causing farmers to fear a recurrence of the wheat rust experienced last year. * * *

Costa Rica, October 27.—* * * The central plateau has experienced heavy seasonal rains during October, which have obstructed communication with the rural districts. * * *

Colombia, October 28.—* * * Heavy rains in the interior of the country are keeping the Magdalena River in excellent condition, so that cargo movement from the coast inland is uninterrupted.

Haiti, October 26.—Adverse weather conditions in Haiti continue to interfere with the normal movement of the coffee crop. * * *

Porto Rico, October 28.—Unfavorable weather has killed plants in the tobacco seed beds in several parts of the island, necessitating a resowing, which will delay planting several weeks in those regions.

Uruguay, October 28.—Sheep shearing has been retarded by the rains throughout the country during the first fortnight of October. * * *

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, SEPTEMBER, 1927

By J. BUSTOS NAVARRETE, Director

[Observatorio del Salto, Santiago, Chile]

In September, 1927, the atmospheric circulation showed unusual activity and as a result the month was generally a period of unsettled, rainy weather.

The most important periods of fair weather under anticyclonic conditions were the following: 3d–4th, 8th–9th, 14th–18th, and 25th–28th.

The depressions bringing the most marked periods of unsettled weather and rain were those charted during the following intervals: 2d–3d, 5th–7th, 9th–11th, 12th–14th, 17th–20th, 21st–22d, and 23d–25th.

The region receiving rainfall extended from Coquimbo to Magellanes. There was marked excess in precipitation in all of the central region of Chile.—*Translated by W. W. Reed.*

METEOROLOGICAL SUMMARY FOR BRAZIL, SEPTEMBER, 1927

By J. DE SAMPAIO FERRAZ, Director

[Directoria de Meteorologia, Rio de Janeiro]

A smaller number of anticyclones crossed the continent in this month, but depressions were more active. Weather was generally unsettled in the south and center of the country, and several gales were registered in the south.

The first "high" appeared on the 8th. Before this, depressions held the sway with a strong gale on the 7th, from the Plata River northwards. The second anticyclone moved over the continent from the 13th to the 19th. On the 20th low pressures dominated again with strong gale in Argentine's coast.

The month closed with a third anticyclone which followed the usual northeast track.

Some late frosts were registered in the south doing some damage to vegetables. Crops generally, well throughout the country.

Rainfall was scarce in the north and center of the country. In the south precipitations were irregular, but on the average above the normals for the month.

Rio's weather ran unsettled in the first 20 days, improving after. Pressure and temperature almost normal. In the first decade winds were abnormally high, specially on the 2d, when Rio was struck by a fairly severe gale. Strong winds were felt again on the 27th.

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASURINGS DURING OCTOBER, 1927

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1924, 52:42, January, 1925, 53:29, and July, 1925, 53:318.

Table 1 shows that solar radiation intensities were below the normal values for October at Washington, D.C., and Lincoln, Nebr., and close to normal at Madison, Wis. It also shows that for the three stations combined, observations were obtained upon a greater number of days than in any previous month since the establishment of the stations.

Table 2 shows an excess in the total solar radiation received on a horizontal surface directly from the sun and diffusely from the sky, at all three stations for which normals have been determined, as compared with the October normals for these stations.

Skylight polarization measurements at Washington made on 8 days give a mean of 55 per cent, with a maximum of 57 per cent on the 4th. At Madison measurements on 11 days give a mean of 69 per cent, with a maximum of 76 per cent on the 21st. These are above normal values for October at Madison and considerably below at Washington.

TABLE 1.—*Solar radiation intensities during October, 1927*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Oct. 4	10.59			1.08	1.19		1.20	1.04			9.83
Oct. 5	6.27		0.81	1.00	1.15	1.31					9.14
Oct. 6	11.84	0.56	0.68	0.83	0.98	1.31	1.04	0.83	0.69	0.58	13.13
Oct. 7	13.13	0.76	0.85	1.00	1.15						14.10
Oct. 10	7.29	0.65	0.77	0.90	1.10	1.39					8.48
Oct. 11	9.14	0.56									9.47
Oct. 14	6.27			1.02	1.12						5.16
Oct. 15	6.27	0.78	0.86	0.98	1.16	1.36					5.79
Oct. 21	6.27	0.65	0.77	0.97	1.17	1.45	1.07	0.82			5.36
Oct. 22	5.56	0.86	0.98	1.10	1.21	1.38	1.12	0.90	0.80	0.72	5.36
Oct. 25	7.57		0.72	0.90	1.12						7.29
Oct. 26	6.76	0.67	0.73	0.88	1.06	1.27					6.76
Oct. 27	6.27	0.81	0.94	1.04	1.22	1.43					8.48
Oct. 29	8.81		0.38	0.50	0.77						7.57
Means		0.70	0.77	0.94	1.11	1.36	1.11	0.90	(0.74)	(0.65)	
Departures		−0.07	−0.07	−0.01	±0.00	−0.07	±0.00	−0.03	−0.06	−0.05	

TABLE 1.—*Solar radiation intensities during October, 1927*—Con.

MADISON, WIS.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A. M.					Air mass P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Oct. 3	8.18		0.97	1.12							7.57
Oct. 4	6.50		0.91				1.20				7.04
Oct. 8	5.79			1.09	1.24						6.76
Oct. 10	5.16			0.97	1.14	1.35					5.36
Oct. 14	4.57			1.09	1.29	1.54					5.56
Oct. 15	6.02			0.86	1.06						7.87
Oct. 17	4.75			1.20							4.37
Oct. 18	5.16		1.06	1.18		1.56	1.36				4.95
Oct. 19	4.95		0.92				1.14				6.50
Oct. 20	6.50				1.24		1.24				8.18
Oct. 21	4.57			1.22	1.36						4.37
Oct. 22	7.04			0.94	1.14		1.17				8.48
Oct. 24	7.57			1.01	1.16						7.87
Oct. 26	8.48			0.80	1.13		1.17				8.81
Oct. 27	8.18				1.12		1.09				10.59
Means			0.96	1.05	1.19	1.48	1.20				
Departures			+0.01	-0.01	±0.00	+0.09	+0.01				

LINCOLN, NEBR.

Date	8 a.m.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	Noon
Oct. 3	7.87								1.04	0.90	7.29
Oct. 4	5.79						1.20	0.97	0.83	0.63	5.41
Oct. 7	6.02				1.27						5.36
Oct. 8	5.79		0.71	0.93	1.28	1.51	1.31	1.14	0.98	0.84	4.17
Oct. 9	4.57							1.18	0.98	0.89	4.75
Oct. 10	6.76	0.88	1.01	1.13	1.22	1.43					8.81
Oct. 13	3.81	1.09	1.15	1.27	1.41	1.55					3.99
Oct. 14	4.57	0.88	1.01	1.14	1.31	1.51					6.02
Oct. 15	6.27	0.87	1.00	1.12	1.25	1.40					6.76
Oct. 17	5.79		0.86	1.03	1.26		1.28	1.09	0.92	0.82	11.38
Oct. 18	4.95	0.72	0.87	1.03	1.23	1.47		1.06	0.91	0.81	5.79
Oct. 19	5.79		0.77	0.97	1.27						7.04
Oct. 20	6.50	0.71	0.75	0.97	1.23				0.96	0.86	5.56
Oct. 21	5.79		0.58	0.93	1.31		1.27	1.10	0.94	0.82	5.36
Oct. 22	6.27		0.95	1.05	1.22		1.23	1.06	0.93	0.81	5.16
Oct. 24	5.79	0.70	0.82	0.87	1.14		1.25				5.36
Oct. 26	6.76		0.92	1.04	1.23		1.18	1.00	0.87	0.77	7.57
Oct. 31	4.57		0.94		1.33						6.50
Means		0.84	0.88	1.04	1.26	1.48	1.25	1.08	0.94	0.82	
Departures		-0.04	-0.07	-0.07	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	

* Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning	Average daily radiation						Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Twin Falls	Washington	Madison	Lincoln
1927	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Oct. 1	374	175	268	195	297	454	+50	-93	-58
Oct. 8	256	242	373	165	223	440	-35	-9	+59
Oct. 15	241	317	385	228	150	410	-33	+91	+77
Oct. 22	296	264	316	221	232	286	+37	+58	+51
Deficiency since first of year on Oct. 28							-8,351	-4,032	-6,146

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. C. S. Freeman, Superintendent U. S. Naval Observatory]

[Data furnished by Naval Observatory, in cooperation with Harvard, Yerkes, and Mount Wilson observatories]

Date	Eastern standard civil time	Heliographic Longitude	Heliographic Latitude	Area[1] Spot	Area[1] Group
1927	h. m.	°	°		
Oct. 1 (Naval Observatory)	11 46	-76.0	+16.0	62	
		-73.0	-10.0	77	
		+46.0	-18.5		247
Oct. 2 (Naval Observatory)	11 45	-71.0	+15.5	123	
		-61.5	+16.0	108	
		-59.0	-9.5	77	
		+59.0	-18.5		185

[1] Areas are corrected for foreshortening and are expressed in millionths of the Sun's visible hemisphere.

Positions and areas of sun spots—Continued

Date	Eastern standard civil time	Heliographic Longitude	Heliographic Latitude	Area Spot	Area Group
1927	h. m.	°	°		
Oct. 3 (Harvard)	11 20	-80.0	+23.0	92	
		+48.0	+17.5	63	
		+63.5	-11.0	135	
		+70.0	-16.0		64
Oct. 3 (Mount Wilson)	15 0	-65.0	+18.0		181
		-46.0	+17.0	4	
		-43.0	-9.0	21	
		+12.0	+12.0		20
		+76.0	-18.0		145
Oct. 4 (Naval Observatory)	11 47	-82.0	-11.0		309
		-60.0	+19.0		154
		-52.0	+15.5		154
		-32.0	-10.0	37	
		+22.5	+10.0		40
Oct. 5 (Naval Observatory)	11 46	-78.0	-18.5		185
		-67.5	-11.0		185
		-49.0	+19.0		170
		-40.0	+15.5		62
		-19.0	-10.0	40	
		+19.5	+20.5		31
		+37.5	+9.5		31
Oct. 6 (Naval Observatory)	11 46	-63.5	-18.5		216
		-55.0	-11.5		231
		-37.0	+19.0		185
		-31.0	+17.5	31	
		-27.5	+15.0		77
		-6.5	-10.0	31	
		+51.5	+8.5	15	
Oct. 7 (Naval Observatory)	11 46	-69.5	+11.0	6	
		-52.0	-18.5		185
		-42.0	-11.5		123
		-22.5	+19.5		185
		-17.5	+17.5	6	
		-12.5	+16.0		62
		+8.0	-9.5	31	
		+12.0	-9.5		12
		+15.0	-9.5		22
		+62.5	+10.0		31
Oct. 8 (Yerkes)	11 31	-37.0	-18.0		200
		-24.0	-12.0		600
		-8.0	+19.0		150
Oct. 9 (Naval Observatory)	12 50	-67.0	-10.0		123
		-48.5	+18.0		31
		-25.5	-19.0		123
		-21.5	-21.0		6
		-11.0	-12.5		300
		+4.0	+19.5		185
		+9.0	+17.5		9
		+14.0	+15.5	31	
		+34.5	-10.0	22	
		+40.5	-9.5		31
		+46.0	-9.5		46
Oct. 10 (Naval Observatory)	11 46	-63.0	+21.0	247	
		-54.0	-9.5		216
		-12.0	-19.0		123
		-9.0	-20.5		15
		+2.5	-12.5		278
		+19.0	+18.0		154
		+60.5	-9.5	46	
Oct. 11 (Naval Observatory)	11 49	-71.5	+21.0	139	
		-39.5	-9.5		185
		+0.5	-20.0		139
		+15.5	-12.5		216
		+31.0	+18.0		93
		+72.0	-10.0		93
Oct. 12 (Mount Wilson)	14 0	-57.5	+20.5	120	
		-24.0	-10.0		424
		-7.5	+15.0		7
		+18.5	-20.5		113
		+31.0	-13.0		181
		+45.0	+19.0		40
Oct. 12 (Harvard)	12 10	-56.5	+22.0	166	
		-24.5	-8.0		430
		+12.5	-18.0	153	
		+30.5	-11.0		184
		+44.5	+19.0		108
Oct. 13 (Naval Observatory)	11 43	-45.5	+21.0	108	
		-20.0	-12.0		62
		-13.0	-11.0		123
		-9.0	-9.0	108	
		+26.0	-20.0		123
		+43.5	-12.5		154
		+54.0	+20.0		46
Oct. 14 (Naval Observatory)	11 44	-32.0	+21.0	93	
		-22.5	-20.0	6	
		+0.5	-11.0		93
		+5.5	-9.0	108	
		+39.5	-20.0		93
		+53.5	-12.0		46
		+62.0	-12.5	123	
		+70.5	+18.0	46	

Positions and areas of sun spots—Continued

Date	Eastern standard civil time	Heliographic		Area	
		Longitude	Latitude	Spot	Group
1927	h. m.	°	°		
Oct. 15 (Naval Observatory)	11 48	−19.0	+21.0	108	------
		+11.0	−11.0	------	62
		+18.0	−9.0	------	154
		+51.0	−20.0	------	139
		+73.0	−13.0	77	------
Oct. 16 (Naval Observatory)	11 46	−85.0	−10.5	------	123
		−79.0	−7.0	93	------
		−5.5	+21.0	123	------
		+26.0	−10.5	------	77
		+31.5	−9.0	------	108
		+65.0	−20.0	------	93
Oct. 17 (Naval Observatory)	14 2	−79.0	+11.0	62	------
		−64.0	−10.5	------	139
		−63.0	−7.0	31	------
		+9.5	+21.0	123	------
		+41.5	−11.0	------	93
		+48.0	−9.0	------	93
		+82.0	−20.0	108	------
Oct. 18 (Yerkes)	15 40	+21.0	+22.0	100	------
Oct. 19 (Mount Wilson)	17 35	−76.0	−19.0	176	------
		−36.0	−10.0	------	124
		−34.0	−7.0	20	------
		+7.0	−30.0	------	4
		+38.0	+20.5	100	------
		+78.0	−9.5	44	------
Oct. 19 (Harvard)	11 35	−72.0	−17.0	172	------
		−36.5	−10.0	------	443
		−35.5	−6.0	38	------
		+35.0	+21.5	113	------
		+75.5	−8.5	117	------
Oct. 20 (Naval Observatory)	13 9	−65.0	−20.0	185	------
		−25.0	−11.0	------	185
		−22.0	−8.0	31	------
		+48.0	+20.0	62	------
Oct. 21 (Naval Observatory)	11 44	−53.0	−19.0	------	216
		−15.0	−10.5	------	77
		−9.5	−8.0	15	------
		−9.0	−11.0	62	------
		+13.5	−7.0	------	62
		+32.5	−29.5	------	46
		+60.0	+20.0	108	------
Oct. 22 (Naval Observatory)	11 44	−39.5	−19.0	------	185
		−1.0	−10.5	------	77
		+4.5	−11.0	31	------
		+19.5	−7.5	------	6
		+26.5	−7.0	------	62
		+39.5	−4.5	93	------
		+46.0	−30.0	------	31
		+49.0	−10.0	------	46
		+72.5	+20.0	108	------
Oct. 23 (Naval Observatory)	13 19	−27.0	−20.0	------	170
		+12.0	−10.5	------	31
		+19.0	−11.0	62	------
		+40.0	−7.5	------	154
		+46.0	−5.0	------	154
		+61.5	−10.5	------	123
Oct. 24 (Naval Observatory)	11 45	−83.0	+21.0	154	------
		−14.0	−19.5	------	185
		+10.0	−18.5	------	31
		+25.0	−11.0	------	15
		+30.5	−11.0	46	------
		+52.0	−7.0	------	185
		+60.0	−6.5	216	------
		+73.5	−11.0	------	139
Oct. 25 (Naval Observatory)	11 45	−70.0	+21.5	93	------
		−5.0	−19.5	------	154
		+43.0	−11.0	31	------
		+66.5	−7.5	------	108
		+74.0	−7.0	216	------
Oct. 26 (Naval Observatory)	11 45	−58.0	+22.0	46	------
		+12.5	−19.5	------	154
		+58.0	−11.0	62	------
		+79.0	−6.0	31	------
Oct. 27 (Naval Observatory)	11 45	−24.5	−17.5	15	------
		−11.0	+17.0	15	------
		+25.5	−19.5	------	93
		+71.0	−11.5	62	------

Positions and areas of sun spots—Continued

Date	Eastern standard civil time	Heliographic		Area	
		Longitude	Latitude	Spot	Group
1927	h. m.	°	°		
Oct. 28 (Naval Observatory)	11 49	+39.0	−19.5	------	62
Oct. 29 (Naval Observatory)	11 46	−82.0	+16.0	62	------
		+50.5	−19.5	------	62
Oct. 30 (Naval Observatory)	11 45	−82.5	+18.5	93	------
		−69.0	+16.0	------	108
		+8.5	+14.5	------	31
		+10.5	+10.0	------	46
		+14.0	−16.5	------	22
		+18.5	−17.5	------	12
		+64.0	−19.5	------	62
Oct. 31 (Naval Observatory)	11 48	−60.5	+18.5	139	------
		−56.0	+15.5	------	93
		+21.5	+16.0	------	62
		+24.0	+10.0	------	46
		+30.5	−17.0	------	93
		+61.0	−19.5	------	62

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR OCTOBER, 1927

(Data supplied by Prof. A. Wolfer, Zurich, Switzerland, October, 1927)

1	43	11	--	21	66
2	32	12	75	22	--
3	52	13	--	23	57
4	65	14	79	24	65
5	82	15	--	25	69
6	82	16	--	26	46
7	85	17	44	27	25
8	90	18	32	28	25
9	97	19	53	29	29
10	--	20	40	30	41
				31	75

Number of observations, 25; mean=58.0.

AEROLOGICAL OBSERVATIONS

By W. R. Stevens

Free-air temperatures were above normal at all aerological stations and at practically all observed levels. The highest temperature of record for October was observed at the 750-meter level at Broken Arrow, from 2,000 to 4,000 meters at Due West, and at 1,000 meters at Royal Center. Fluctuations in temperature in the free air from day to day were unusually small for this season of the year. The characteristic nocturnal autumn and winter surface inversion of middle and high latitudes of the Temperate Zones was observed frequently enough and of sufficient magnitude to appear in the means for the month at Ellendale, while the means near the surface show practically isothermal conditions at Broken Arrow, Groesbeck, and Royal Center.

Relative humidities were mostly below, and vapor pressures were near normal.

Free-air wind resultants were about normal. Easterly winds at high levels were observed at a number of Pacific coast and Rocky Mountain stations from the 16th to the 22d. Quite often easterly winds at high altitudes are accompanied and followed by stagnant conditions at the surface. In this connection we find that the period 16th–22d was one of unusual inactivity for western portions of the United States, with temperatures considerably above the normal.

METEOROLOGICAL CONDITIONS OVER ROYAL CENTER, IND., OCTOBER 5-7, 1927

Time	Altitude	Temperature	Relative humidity	Wind Direction	Wind Velocity
	Meters	*° C.*	*Per cent*		*M. p. s.*
6:37 a. m., 5th	225	10.2	82	SSE	3.6
	500	14.3	50	S	10.3
	750	14.3	37	SSW	10.5
	1,000	16.0	17	SSW	10.1
	1,500	13.3	17	SW	9.3
	2,000	10.2	21	WSW	8.3
	2,500	6.9	26	WSW	8.5
	3,000	3.3	32	WSW	10.3
	3,500	−0.3	38	WSW	12.1
	4,000	−4.2	50	W	14.5
	4,500	−4.7	21	W	16.9
	5,000	−7.0	15	W	20.3
	5,500	−9.3	8	W	23.7
6:30 a. m., 6th	225	14.3	74	S	3.6
	500	19.1	60	SSW	14.6
	750	20.1	58	SW	17.8
	1,000	17.9	68	SW	14.4
	1,500	13.2	78	SW	10.1
	2,000	9.4	83	SW	7.7
	2,500	9.3	30	SW	11.3
	3,000	6.9	39	SW	14.1
	3,500	2.9	59	SW	15.0
	4,000	−1.6	82	SW	14.9
	4,500	−5.7	92	SW	16.3
10:15 a. m., 7th	225	11.9	88	NNW	5.8
	500	9.0	95	N	8.2
	750	7.8	98	N	7.3
	1,000	6.9	99	NNW	5.5
	1,500	5.3	100	NNW	8.2
	2,000	8.3	52	NW	12.3
	2,500	7.6	29	WNW	13.6
	3,000	3.5	30	W	13.0
	3,500	0.9	33	W	16.3
	4,000	−3.7	47	W	20.7
	4,500	−6.4	43	W	21.5

Kite flights were made on the morning of the 1st at Broken Arrow and Groesbeck within a low-pressure area which was central over western Texas. This LOW, which subsequently moved NNE., was attended by heavy precipitation in eastern Texas and Oklahoma the following afternoon and night. (Palestine, 4.22, Taylor, 3.94, Dallas, 3.06, Groesbeck, 8.87, Oklahoma City, 7.08 inches.) Analysis of surface and upper-air observations indicates that these unusual rains were the result of a strong northward acceleration of warm, humid, Gulf air and simultaneous importation of colder air at higher levels while the LOW was occluding. The above phenomena are not sufficient to cause such heavy rains unless they prevail over a comparatively long period. However, in this case the slow west-to-east advance of the trough and the slow rate of occlusion permitted prolonged instability.

The three flights made at Royal Center on the 5th-7th, all of which reached an altitude of at least 4,500 meters are representative of warm and cold front conditions. The ascent of the 5th was made on the rear of a HIGH which covered the eastern portion of the country. The flight of the 6th was made in a trough which extended from northern Quebec to Kansas, and that of the 7th was obtained shortly after the passage of the cold front.

It is of interest to see that throughout this series of flights there was only a small change in temperature at 4,500 meters.

In connection with the International Days, 14th-15th, series flights were made covering 36-48 hour periods at all kite stations except Groesbeck, where light winds interfered. Many balloon stations made special observations from 14th-22d which had been designated as International Week.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during October, 1927*

TEMPERATURE (°C.)

Altitude, m. s. e. (meters)	Broken Arrow, Okla. (233 meters) Mean	Departure from 10-year mean	Due West, S. C. (217 meters) Mean	Departure from 7-year mean	Ellendale, N. Dak. (444 meters) Mean	Departure from 10-year mean	Groesbeck, Tex. (141 meters) Mean	Departure from 10-year mean	Royal Center, (225 meters) Mean	Departure from 10-year mean	Washington, D. C.* (7 meters) Mean	Departure from 3-year mean
Surface	18.7	+1.9	18.2	+1.6	8.0	+0.8	19.6	+0.7	12.8	−0.2	18.2	+4.2
250	18.7	+2.0	18.0	+1.7			19.8	+1.1	12.9	0.0	17.1	+4.0
500	18.3	+2.7	16.9	+2.3	8.4	+1.1	19.7	+1.9	12.8	+1.1	16.2	+3.9
750	17.8	+3.2	15.8	+2.5	9.7	+2.4	18.5	+1.8	12.1	+1.7	14.9	+3.8
1,000	16.8	+3.2	14.5	+2.3	9.5	+1.6	17.2	+1.6	11.2	+2.0	13.5	+3.7
1,250	15.8	+3.1	13.0	+2.0	9.1	+2.0	15.9	+1.2	10.0	+2.0	12.3	+3.8
1,500	14.4	+2.7	11.7	+1.8	8.6	+2.4	14.6	+1.0	8.8	+1.9	10.9	+3.6
2,000	11.5	+2.0	9.5	+1.4	6.2	+2.2	11.5	+0.1	6.5	+2.0	8.5	+3.2
2,500	8.5	+1.5	6.9	+0.7	3.4	+1.9	9.1	0.0	4.0	+1.8	6.0	+2.4
3,000	5.2	+1.0	4.6	+0.7	0.4	+1.6	6.3	−0.5	1.6	+1.8	4.6	+2.9
3,500	2.9	+1.5	1.6	+0.4	−2.8	+1.2	3.1	−1.3	−1.1	+1.6	2.7	+3.3
4,000	−0.4	+0.9	−0.8	+0.8	−5.6	+1.2	0.2	−1.6	−4.2	+1.0	0.9	+3.7
4,500					−8.3	+1.3			−7.3	+0.8		
5,000									−9.9	+0.8		

RELATIVE HUMIDITY (%)

Altitude	Broken Arrow Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure	Washington Mean	Departure
Surface	63	−3	62	−1	71	+2	74	+1	72	+3	61	−11
250	62	−4	62	−1			68	−3	71	+2	59	−9
500	55	−7	57	−5	66	+1	58	−10	63	−3	57	−8
750	50	−10	56	−6	59	−3	56	−11	58	−7	57	−8
1,000	48	−10	57	−5	55	−5	56	−9	53	−10	56	−10
1,250	45	−11	57	−4	50	−8	53	−9	51	−10	54	−13
1,500	44	−10	53	−5	48	−7	49	−11	47	−11	52	−15
2,000	41	−8	46	−5	51	−1	50	−5	40	−13	46	−18
2,500	40	−5	44	−1	52	+2	38	−11	37	−12	42	−15
3,000	39	−3	42	−1	51	+3	29	−14	33	−14	36	−14
3,500	43	+3	61	+19	52	+4	35	−6	38	−8	32	−15
4,000	37	+2			38	−9	34	−6	43	−1	28	−15
4,500					30	−16			42	−1		
5,000									33	−1		

VAPOR PRESSURE (mb.)

Altitude	Broken Arrow Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure	Washington Mean	Departure
Surface	13.63	+0.64	13.33	+0.90	7.30	+0.28	16.99	+0.43	10.56	0.00	12.82	+0.80
250	13.49	+0.60	13.13	+0.89			15.96	+0.06	10.46	+0.02	11.68	+0.85
500	11.96	+0.38	11.41	+0.46	7.22	+0.31	13.63	−0.71	9.33	+0.10	10.62	+0.74
750	10.42	−0.09	10.30	+0.28	6.69	+0.28	12.37	−0.85	8.09	−0.18	9.68	+0.46
1,000	9.33	−0.29	9.71	+0.43	6.04	+0.18	11.26	−0.74	6.98	−0.46	8.76	+0.17
1,250	8.15	−0.56	8.97	+0.56	5.37	+0.06	9.74	−0.96	6.21	−0.42	7.70	−0.23
1,500	7.27	−0.59	7.66	+0.28	4.89	+0.11	8.26	−1.30	5.30	−0.52	6.76	−0.46
2,000	5.62	−0.43	5.59	+0.01	4.46	+0.51	6.44	−0.79	4.02	−0.53	5.18	−0.58
2,500	4.29	−0.35	4.56	+0.20	3.82	+0.58	3.73	−1.77	2.99	−0.58	4.15	−0.37
3,000	3.53	−0.02	3.61	+0.08	3.10	+0.49	2.11	−1.97	2.26	−0.65	3.53	+0.13
3,500	3.37	+0.63	4.14	+1.25	2.47	+0.32	1.94	−1.28	2.17	−0.27	3.05	+0.52
4,000	2.25	+0.34			1.69	−0.03	1.16	−1.48	1.68	−0.19	2.75	+0.99
4,500					1.35	0.00			1.07	−0.31		
5,000									0.57	−0.31		

*Naval Air Station, District of Columbia.

TABLE 2.—*Free-air resultant winds (m. p. s.) during October, 1927*

Altitude, m. s. l. (meters)	Broken Arrow, Okla. (233 meters) Mean Dir.	Vel.	10-year mean Dir.	Vel.	Due West, S. C. (217 meters) Mean Dir.	Vel.	7-year mean Dir.	Vel.	Ellendale, N. Dak. (444 meters) Mean Dir.	Vel.	10-year mean Dir.	Vel.
Surface	S. 34°W.	3.0	S. 3°W.	2.2	N. 24°E.	1.4	N. 43°E.	1.6	N. 70°W.	2.0	N. 71°W.	1.9
250	S. 33°W.	3.2	S. 2°W.	2.4	N. 27°E.	1.3	N. 43°E.	1.8				
500	S. 36°W.	4.9	S. 10°W.	3.6	N. 27°E.	1.5	N. 47°E.	2.2	N. 79°W.	2.2	N. 78°W.	2.0
750	S. 40°W.	5.4	S. 18°W.	4.2	N. 16°E.	1.0	N. 47°E.	1.8	N. 78°W.	2.5	N. 86°W.	2.9
1,000	S. 42°W.	6.2	S. 26°W.	4.3	N. 14°E.	1.3	N. 29°E.	1.0	N. 82°W.	3.7	N. 85°W.	3.6
1,250	S. 43°W.	6.2	S. 39°W.	4.5	N. 6°W.	1.1	N. 36°W.	0.9	N. 76°W.	4.5	N. 82°W.	4.3
1,500	S. 55°W.	6.1	S. 48°W.	4.7	N. 28°W.	1.9	N. 72°W.	1.6	N. 82°W.	4.9	N. 83°W.	5.0
2,000	S. 66°W.	6.0	S. 57°W.	5.1	N. 38°W.	2.2	N. 78°W.	2.4	N. 79°W.	7.2	N. 81°W.	6.7
2,500	S. 67°W.	6.9	S. 70°W.	5.8	N. 50°W.	2.2	N. 80°W.	4.3	N. 68°W.	9.6	N. 77°W.	8.2
3,000	S. 60°W.	8.4	S. 68°W.	6.8	N. 30°W.	3.0	N. 84°W.	5.1	N. 64°W.	12.2	N. 78°W.	9.5
3,500	S. 54°W.	9.7	S. 74°W.	7.9	S. 53°E.	4.5	S. 89°W.	6.2	N. 66°W.	12.9	N. 82°W.	11.2
4,000	S. 56°W.	12.8	S. 67°W.	8.9	S. 67°E.	13.0	S. 81°W.	5.8	N. 68°W.	15.6	N. 86°W.	12.0
4,500									W.	14.0	S. 84°W.	13.4
5,000									W.	15.0	N. 86°W.	14.6

Altitude, m. s. l. (meters)	Groesbeck, Tex. (141 meters) Mean Dir.	Vel.	10-year mean Dir.	Vel.	Royal Center, Ind. (225 meters) Mean Dir.	Vel.	10-year mean Dir.	Vel.	Washington, D. C. (34 meters) Mean Dir.	Vel.	7-year mean Dir.	Vel.
Surface	S. 6°E.	1.5	S. 50°E.	0.8	S. 57°W.	1.7	S. 50°W.	2.2	N. 46°W.	0.5	N. 51°W.	1.0
250	S. 17°E.	1.8	S. 39°E.	1.4	S. 55°W.	1.9	S. 48°W.	2.4	N. 69°W.	1.9	N. 48°W.	2.3
500	S.	3.0	S. 20°E.	2.6	S. 63°W.	4.7	S. 57°W.	4.8	N. 80°W.	2.7	N. 55°W.	3.0
750	S. 6°W.	2.9	S. 12°E.	2.9	S. 72°W.	5.4	S. 66°W.	5.9	N. 83°W.	3.8	N. 62°W.	3.9
1,000	S. 10°W.	2.8	S.	2.8	S. 84°W.	5.8	S. 72°W.	6.4	N. 69°W.	4.2	N. 60°W.	4.8
1,250	S. 15°W.	2.7	S. 12°W.	3.0	S. 87°W.	6.9	S. 76°W.	7.4				
1,500	S. 6°W.	3.1	S. 22°W.	2.9	N. 84°W.	6.4	S. 81°W.	7.9	N. 60°W.	5.5	N. 59°W.	6.3
2,000	S. 10°W.	4.7	S. 41°W.	3.1	N. 81°W.	7.5	S. 84°W.	9.3	N. 54°W.	7.1	N. 63°W.	6.9
2,500	S. 4°W.	6.0	S. 48°W.	3.5	N. 84°W.	8.7	S. 89°W.	10.2	N. 58°W.	8.4	N. 66°W.	7.8
3,000	S. 18°W.	4.6	S. 58°W.	3.8	N. 85°W.	8.8	N. 89°W.	11.0	N. 59°W.	8.5	N. 70°W.	8.2
3,500	S. 41°W.	2.9	S. 58°W.	3.9	N. 68°W.	11.0	N. 87°W.	12.8	N. 61°W.	8.9	N. 72°W.	9.2
4,000	S. 30°W.	5.2	S. 48°W.	4.0	S. 87°W.	17.0	N. 89°W.	14.4	N. 71°W.	7.9	N. 77°W.	9.8
4,500					S. 83°W.	18.1	S. 84°W.	17.6	S. 84°W.	7.7	N. 80°W.	9.2
5,000					N. 76°W.	17.4	N. 88°W.	17.9	S. 89°W.	8.5	N. 76°W.	9.6

THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

A warm October (see Chart III), with temperature uniformly above normal—a rather unusual occurrence. Killing frost was less prevalent and did not extend quite so far south as in a normal October.

For the country as a whole, precipitation was a shade greater than normal, and this, too, is unusual. On the northwestern coast there were indications toward the close of the month of the close approach of an oceanic depression of the barometer which is usually associated with generous rains west of the Rocky Mountains. The usual details follow.—*A. J. H.*

CYCLONES AND ANTICYCLONES

The tracks of 15 low-pressure areas are plotted on Chart II for October. Two of these, I and VI, were of tropical origin, but did not attain hurricane intensity. Two other slight disturbances passed over the Lesser Antilles, the first during the 15th and 16th and the second during the 28th to 31st. The latter pair were absorbed in passing extra-tropical disturbances.

The tracks of 14 high-pressure areas are plotted on Chart I; none of these were important.—*W. P. Day.*

THE WEATHER ELEMENTS

By P. C. Day

PRESSURE AND WINDS

The marked features of the weather during October, 1927, were the widespread excess of temperature, practically all stations reporting monthly means in excess of the normal, and the long period of unusual heat, lack of precipitation, and excessive sunshine that prevailed with but few local interruptions over nearly the entire country from the 14th to 28th.

The month opened with an area of low pressure over the southern Plains, attended by general rains and thunderstorms from Oklahoma and Arkansas northeastward to the Lake Michigan area, with heavy rains in the middle Mississippi Valley and some near-by areas. By the morning of the 2d heavy to excessive rains had continued in portions of the Mississippi Valley, particularly in Iowa and Missouri; also there were some unusually heavy rains in Texas and Oklahoma, Oklahoma City reporting more than 8 inches during the preceding 24 hours, and general rains had extended to the northward and over the Great Lakes. During the following 24 hours precipitation had generally ceased, though some extension had occurred in the rain area. At the same time a moderate barometric depression had moved northward along the Florida coast, and at the morning observation of the 3d was central over eastern South Carolina, and heavy rains had fallen in near-by areas. This cyclone moved northward near the coast, and on the morning of the 4th was central off the New England coast, and heavy rains had occurred along its path, with lighter rains extending westward into the upper Ohio Valley and lower Lake region.

On the 3d a cyclonic area entered the far Northwest, and by the 4th it had extended eastward into the northern Rocky Mountains, but with decreased intensity; precipitation, which was heavy in a few localities near the coast, was confined mainly to the northern districts from Montana westward. On the 6th low pressure developed in eastern Kansas and moved rapidly during the following day to Ontario, attended by rather widespread and locally heavy precipitation from the Mississippi Valley eastward to the Atlantic coast, the rains being augmented somewhat on the 7th by a secondary depression in the lower Mississippi Valley. This depression moved eastward to near the south Atlantic coast by the morning of the 8th and to the northeastward off the coast during the following day, attended by some local heavy rains from the North Carolina coast to Chesapeake Bay and by moderate rains in other portions of the Atlantic coast area.

On the morning of the 11th low pressure covered the Plains States, with centers over North Dakota and Oklahoma, attended by rain or snow over portions of the northern States from Montana eastward to Lake Superior. By the following morning important precipitation had occurred over most districts from the middle and northern Plains eastward to the Great Lakes and southeastward to the Gulf and south Atlantic coasts, heavy rains occurring locally from the middle Mississippi Valley southeastward to Alabama and near-by areas. With the further eastward progress of the storm during the 13th, precipitation continued over the more eastern districts and extended into the Northeastern States, with heavy rains along the Atlantic coast from North Carolina to New England.

After the passing of the storm referred to no important cyclone occurred over the country until near the end of the month, save from the 18th to 20th, when a tropical disturbance approached the Middle Atlantic coast, entering southern New England on the 19th and passing to the lower St. Lawrence Valley on the following day, attended by some heavy rains near the coast and by lighter rains as far west as the upper Ohio Valley and lower Lake region.

After an exceptionally long period covering much of the second and third decades without important precipitation over the greater part of the country, a disturbance appeared over the far Southwest on the morning of the 28th and moved northeastward to the Red River Valley of the North by the 30th, attended by light to moderate precipitation over most of the Rocky Mountain and near-by Plains areas. Over the central and eastern districts this period continued in the main without additional precipitation.

The mean atmospheric pressure reduced to sea level was below normal in all portions of the United States, save in the Rocky Mountain and Plateau regions where it was slightly above normal, and it was below also in Canada. Over the northeastern districts and in the Canadian Northwest the departures were moderately large. Compared with the average pressures for the preceding month they were everywhere higher save in the northeastern districts, where the averages were slightly less than in September.

There were few high winds or local heavy storms, though small tornadoes were reported from scattered points in Texas on the 1st, and from Arkansas, Oklahoma, and Kansas on the following day; otherwise little damage was reported except on the 11th, when a rather severe tornado occurred in the vicinity of Dill, Ark., causing the death of five persons and the wrecking of many homes and damage to other property. The full details of these and other storms appear in the table at the end of this section.

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The prevailing winds were not well defined, as might be expected from the rather uneventful atmospheric condition, but they were mainly from southerly points in the Great Plains, Central Valleys, and Northeastern States, from north or northeast over the Southeastern States, and variable elsewhere.

TEMPERATURE

The first decade was mainly somewhat cooler than normal over most western districts, but generally warmer in the more eastern, some unusually high temperatures occurring during the first few days over most districts from the Mississippi River eastward. This was particularly the case in the more northeastern districts where the maximum temperatures on the 1st or 2d were in numerous instances the highest of record for October. Beginning about the 13th higher temperatures set in over the West, and there was a general tendency to increasing warmth in more eastern districts until by the end of the second decade they were above normal over nearly all districts, except locally in the Southeast, where on the 19th, particularly in Florida, temperatures were remarkably low, in a few instances the lowest of record for October.

The last decade of the month was remarkable for the persistent warmth, and for almost continuous sunshine, at least over the eastern two thirds. During this period the daily maximum temperatures were in numerous instances the highest of record for so late in the month and over large areas in the central districts constituted the longest period of unusual warmth ever known at that period of the year.

For the month as a whole the average temperature was above normal in every part of the country, save extreme southern Florida, and similar conditions existed in Canada. Over the interior districts the averages ranged from 3° to 6° above normal, and in a few instances they were the highest of record for the month. Chart III of this REVIEW illustrates the extent and uniformity of the temperature variations from normal. The warmest periods of the month were during the first few days over most districts from the Mississippi River eastward; about the 15th to 18th from the Rocky Mountains westward; and from the 19th to 26th in the Great Plains States. Maximum temperatures above 90° were reported on numerous dates in many of the States and they were 100° or slightly higher in the Southwest and locally in a few of the interior States. The maximum reported was 110° in southern California, and 107° was reported from Arizona.

The periods of lowest temperatures were mainly about the 18th to 20th over the Southeastern States, and locally in the Lake region, Ohio Valley and nearby areas, and on the 30th or 31st in the far Northwest and from Pennsylvania and New Jersey to New England. Minimum temperatures were freezing or lower some time during the month at points in all the States save Florida, where no temperatures lower than 34° was observed. Temperatures below 20° were observed in all the northern border States, and they were below 10° at exposed points in most of the western mountains, the lowest observed during the month, 5° below zero, occurred at elevated points in Colorado and Wyoming.

Killing frosts made no important advance into the great agricultural districts beyond what was shown at the end of September, and over nearly all central and many southern districts, where killing frost has usually occurred before the end of October, no injury had yet been sustained by growing vegetation.

PRECIPITATION

Compared with the normal, October, 1927, precipitation was deficient over large areas, though most sections had sufficient for present needs and indeed large portions of the central valleys had unfavorably heavy rains during the first half. The latter half of the month, however, was unusually dry, large areas of the central and eastern sections having no appreciable falls during the entire period. As a result, record-breaking periods without precipitation for the season of the year were established locally, though, on account of the excess of moisture in the early part of the month over much of the great agricultural area this lack of precipitation was not particularly harmful.

The monthly amounts from the Carolinas to New England were mainly above normal, and a few sections in the Middle Atlantic coast area had more rain than in any previous October. There were also substantial excesses in portions of the middle Mississippi Valley and locally in Texas. In the far West there was a slight excess of precipitation in Washington and California, as well as locally in Arizona. Over much of California, Nevada, and Arizona, there was practically no precipitation until the 24th, after which it was of frequent occurrence and very beneficial.

SNOWFALL

There was little snowfall save in the mountain regions of the West, and here the amounts were usually less than normal. Only traces were reported from the upper Lake region and practically none occurred in New England.

In portions of the Rocky Mountains, particularly in Colorado and Wyoming, there were total falls during the month amounting locally to 2 feet or more, and similar totals were reported from some of the high elevations of the Sierra Nevada.

SUNSHINE

The last half of the month had an unusual percentage of clear sky, particularly between the Allegheny and Rocky Mountains, where frequently for many days no clouds were observed and 100 per cent of the possible sunshine occurred.

RELATIVE HUMIDITY

The percentage of relative humidity was less than normal in the greater part of the country, as might be expected from the general excess of warmth and sunshine. The deficiency was greatest, 10 to 15 percent, over the Rocky Mountain region, and nearly as great in some of the southeastern sections. There was a slight excess near the upper Lakes and over some of the Northeastern States.

SEVERE LOCAL STORMS, OCTOBER, 1927

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Campbell, Tex. (near)	1	4:30 p. m.	200		$4,500	Tornado	Some damage to buildings and crops	Official, U. S. Weather Bureau.
Letot, Tex. (near)	1	6:50 p. m.	440		7,500	do	Buildings damaged; 3 persons injured; path 1½ miles long.	Do.
Ladonia, Tex. (near)	1	8:30 p. m.	100		20,000	do	Considerable damage to property; 3 persons seriously injured; path ¾ mile long.	Do.
Quinton (near), to Whitefield, Okla.	1	8:45-11:15 p. m.	150-300		31,500	do	Considerable damage to property other than crops; 39 persons injured.	Do.
Columbus, Kans. (near)	2	12:15 a. m.	200		10,000	do	A score of farm buildings demolished; power lines damaged; livestock killed.	Do.
Gentry, Ark. (4 miles west of).	2	1 a. m.				do.	Houses unroofed; barns demolished; 2 homes moved from foundations; orchard uprooted.	The Record (Fort Smith, Ark.).
Milwaukee, Wis	2	P. m.				Wind	Wires blown down; trees broken; traffic impeded	Official, U. S. Weather Bureau.
Missouri (southwestern)	2-3				5,300	do	Buildings and crops damaged; tornadic wind near Neosho.	Do.
Monroe and Iowa Counties, Iowa.	3	2:30 p. m.				Hail	Crops injured	Do.
Milwaukee, Wis	6	P. m.			2,000	Rain and wind	Overhead wires damaged; basements flooded; pavements washed out.	Do.
Sycamore, Ill. (near)	8	7:30 p. m.	880			Wind	Damage to property and vegetation over path 3 miles in length.	Do.
Dill, Ark	11	11:30 p. m.	200	5	30,000	Tornado	Many homes wrecked or damaged; gin machinery ruined; 31 persons injured.	Arkansas Gazette (Little Rock, Ark.).
New York (central and southeastern).	12					Rain and high wind.	Streets and cellars flooded; trees, telephone and power lines considerably damaged by wind.	Official, U. S. Weather Bureau.
Ashland County, Wis. (south-central).	30	4:30 p. m.	880		1,200	Probably small tornado.	Roofs of several houses and barns blown off; haystacks scattered.	Do.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

On the 2d storm warnings were ordered between Daytona, Fla., and Savannah, Ga., in connection with a disturbance that apparently developed off the northeast Florida coast and moved north-northwest, crossing the coast line between Savannah and Charleston. The only strong winds were reported near Charleston. The disturbance was of very small extent and short duration, but was seemingly quite severe at the time it crossed the coast line. This disturbance redeveloped being central over Virginia on the evening of the 3d when storm warnings were ordered from Delaware Breakwater to Eastport. Winds of gale force occurred over the region of display.

In connection with a disturbance of marked intensity central over eastern Lake Superior on the evening of the 12th, storm warnings were ordered from Hatteras to Eastport.

The first indication of a tropical disturbance during the month appeared over the northwestern Caribbean on the evening of the 16th and advices were issued generally to shipping and storm warnings were ordered from Punta Gorda to Miami, Fla. As the disturbance moved east by north, to the south of Cuba storm warnings were ordered down. The disturbance was of small extent but of moderate intensity causing some destruction to crops as it passed northeast over extreme eastern Cuba during the night of the 18th.

During this time another disturbance developed in about latitude 30°, longitude 75°, and moved northward. On the afternoon of the 17th storm warnings were ordered from Delaware Breakwater to Eastport, and on the evening of that date extended southward to Wilmington, N. C., and on the morning of the 18th extended northward to Eastport. Warnings were continued on the 19th from Hatteras to Eastport. Strong winds and gales were general.

A tropical disturbance of very slight character passed over St. Lucia, Windward Islands, during the night of the 28th. It thence moved northwestward passing through the Mona Passage and trace of it was lost northeast of the Bahamas. So far as reports received up to this time indicate it was not of any appreciable energy.

Small-craft warnings were issued on the 9th between Atlantic City and Boston.

Frost warnings were ordered on the 8th, 10th, 12th, 13th, 14th, 16th, 17th, 18th and 19th.—*R. H. Weightman.*

CHICAGO FORECAST DISTRICT

The outstanding feature in the Chicago forecast district during October, 1927, was a period of remarkably mild, pleasant weather during the latter half of the month. It began soon after the middle of the month and lasted until the close. Almost daily from the 19th until the 31st one or more stations in the district reported the highest temperatures of record for so late in the season. Furthermore, virtually no precipitation occurred during this period until the 28th.

Frost warnings.—At the beginning of the month frost warnings were still required over most of the district, except the extreme northern portion, but by the close most vegetation had been killed by frost except in southern and extreme eastern Kansas, Missouri, and the southern portions of Illinois and Indiana. Frost warnings, more or less general in scope, were issued on 17 dates. None was issued, however, between the 24th and 29th, inclusive, when the remarkable mild period above referred to was prevalent.

Storm warnings.—Conditions required the rather frequent issuance of either small-craft or storm warnings during the first three weeks of the month. Most of these were small-craft warnings, but storm warnings were necessary in a few cases.

On the morning of the 2d storm warnings were issued for the Upper Lakes for a disturbance that had moved north-northeastward from Texas to the Upper Mississippi Valley. This warning was justified except on Lake Huron.

Storm warnings were again issued on the night of the 10th in connection with a disturbance that was advancing from the Northwest. The storm lost force during the night and the warnings were changed to those for small craft on the following morning. On the night of the 11th–

12th, however, this disturbance underwent a recrudescence, so that storm warnings had to be issued for Lake Ontario and extreme eastern Lake Erie on the following morning. The warning was fully verified.

The next disturbance of import was one from tropical waters. On the morning of the 18th the center was off the Delaware coast and the winds were becoming strong over portions of the Lower Lakes. Accordingly, northeast storm warnings were issued for Lake Ontario and for Lake Erie from Cleveland eastward. Full verification of this warning resulted. In fact, this disturbance, together with related barometric conditions to the westward, required the issuance of either small-craft or storm warnings on the following two days.

Fire-weather warnings.—On the 16th a dry period began in Minnesota that gave that State its highest fire hazard since May, 1926. A large number of fires occurred from October 18 to 29. General fire-weather forecasts were sent to the Duluth, Minn., office on several dates, where they were put in shape for distribution by the official especially assigned to that work. Eight such forecasts were issued for the Minnesota area. This work was also extended into Upper Michigan during October, and five fire-weather forecasts for that area were issued.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

The weather during October was exceptionally mild throughout the district except for a cold period in the second decade. A striking feature was the absence of precipitation during the second and third decades.

No storm warnings were issued. Small-craft warnings were displayed on the Texas coast on October 1. No general storms occurred without warnings.

Frost warnings were issued for the northwest portion of the district on the 2d and 3d; for the north portion of the district on the 12th, and northern Arkansas on the 13th, and Oklahoma and Arkansas on the 19th. Frost occurred over part of the area covered in the forecast.

Norther warnings for shipping on the Mexican coast were issued on the 12th.—*I. M. Cline.*

DENVER FORECAST DISTRICT

Mild temperatures and settled weather prevailed throughout the district during most of the month, the principal exceptions being rather stormy weather in the northern portion of the district during the first week and in the southern portion during the last few days. Warnings of frosts or freezing temperatures were issued from time to time as long as they were required for parts of Wyoming, Colorado, Utah, and New Mexico, and advices of expected fresh to strong winds in southern Wyoming and northeastern Colorado were issued for the benefit of the air-mail flyers on the 4th, 9th, 10th, 13th, and 14th. Most of the above-mentioned warnings were verified either fully or in part. On the 31st, when rain or snow and colder weather with fresh to strong northerly winds was indicated, livestock warnings were issued for eastern and southern Wyoming. Moderately severe conditions were experienced in the southeastern part of the State, many automobiles being marooned by drifted snow on the main highways in the vicinity of Laramie.—*E. B. Gittings.*

SAN FRANCISCO FORECAST DISTRICT

The North Pacific high-pressure system was above its normal intensity at the opening of the month, its major axis lying in a northwest-southeast position, and favoring the development of disturbances on its northeast periphery. Two such disturbances developed early in the month, one on the 1st and another on the 3d. The second was attended by strong winds and gales along the north coast, but no warnings were displayed as the depression formed over the district without premonitory indications. A disturbance from the Gulf of Alaska on the 9th appeared to warrant the display of small-craft warnings on that date over Puget Sound and on the Washington coast, and fresh winds followed over much of the area reaching moderate gale force at points on the coast. A deep and very large depression developed over the northeast Pacific a few days later, warnings for which were displayed at northern ports on the 14th. These warnings continued in force until the 17th, but were changed in character at times to indicate the force and direction of the blow, and included a display of "whole gale" warnings on the Washington-Oregon coast from the evening of the 14th to the morning of the 16th. Strong to whole gales prevailed over much of the region covered by the warnings, beginning with the 15th. No further storm warnings were issued until the 28th, when they were ordered for the Washington-Oregon coast. Strong winds and gales occurred during the same day, subsiding by night.

Special fire-weather forecasts for northern California, which had been a feature of the daily forecast work since the beginning of the fire season, were discontinued on the 26th, due to the occurrence of rains which mitigated the fire hazard in all parts of the State on that date.—*Thomas R. Reed.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD

Atlantic drainage—Between October 16 and 20 heavy rains fell over the Susquehanna drainage basin, except the extreme upper portion. Some of the heavier amounts were as follows:

	Inches		Inches
Cortland, N. Y.	2.30	Montrose, Pa.	5.05
New Berlin, N. Y.	3.22	Towanda, Pa.	3.83
Oneonta, N. Y.	3.68	Wilkes-Barre, Pa.	4.17
Sherburne, N. Y.	2.52	Sunbury, Pa.	3.36
Bainbridge, N. Y.	3.90	Harrisburg, Pa.	2.82
Binghamton, N. Y.	4.60		

There followed, of course, a rapid rise in the river and moderate flood stages occurred almost as far down as the junction with the West Branch. Fortunately, the lowlands had been well cleared of crops, road and bridge work was practically complete, and the resulting flood damage was relatively small. The total of reported losses was $60,000, and property to the value of $5,000 was saved through the warnings. Apparently there was considerable crop damage, but figures were unobtainable.

The same general rain storm also caused a pronounced rise in Delaware River and tributaries, although no flood stages were reported, except at Hawley, Pa., on the Lackawaxen River. The Lackawanna River also overflowed its banks, and caused much damage and inconvenience throughout the valley, especially in and around Scranton, Pa.

Heavy rains over the upper Roanoke, upper Cape Fear, and upper Peedee drainage basins occurred on October 3 and 4 caused decided rises, which were covered by warnings for the streams mentioned. The overflow was not serious and there was little or no damage.

Mississippi drainage.—The rains of the last days of September and early October brought about moderate floods in the Illinois River of Illinois and the Grand and Osage Rivers of Missouri. The floods were moderate and well covered by warnings. Losses and damage were small since no crops had been planted in the newly overflowed areas after the destructive spring and early summer floods.

The same general and heavy rainstorms above mentioned also covered southern Kansas, eastern Oklahoma and Arkansas, and quite severe floods followed in the lower Neosho and lower Verdigris Rivers of Kansas and Oklahoma. Stages were also well above the flood line in the Arkansas River from Webbers Falls, Okla., almost to Little Rock, Ark., and in the White River of Arkansas, except the extreme upper and extreme lower portions, and a local flood was reported at Oklahoma City, Okla.

The highest stages, both relative and absolute, occurred in the Verdigris River above Catoosa, Okla., below which place the crest was greatly depressed. At Independence, Kans., the Verdigris River reached a stage of 45.95 feet on October 3, 15.95 feet above the flood stage and within 0.7 foot of the record stage of July 8, 1904.

The lower Neosho River flood was almost equal to the flood of April, 1927, although not nearly so destructive as the Verdigris flood, while the North Canadian River flood at Oklahoma City, Okla., was confined to that vicinity without material damage resulting. Only low bottom lands from the city eastward were flooded. The Arkansas and White River floods were more moderate, and the total of losses reported was not great.

Timely warnings were issued for all these floods, and reported savings through them were $25,000 along the Neosho River, $150,000 along the Verdigris River, and $15,000 along the White River. Incomplete data as to loss and damage are as follows:

River basin	Miscellaneous	Crops		Livestock and other movable property	Suspension of business	Total
		Matured	Prospective			
Neosho	$25,000	$15,000	$35,000	$20,000	$5,000	$100,000
Osage in Kansas	25,000					25,000
Verdigris	1,270,000			75,000		1,345,000
White	97,000					97,000
Total	1,417,000	15,000	35,000	95,000	5,000	1,567,000

About 15,000 acres of crop lands were overflowed in the Neosho Basin. Highways in Labette and southern Neosho Counties of Kansas were impassable for several days, and railroad traffic along low places interrupted. In the Verdigris Basin about 90,000 acres of land were overflowed, 65,000 acres of which are in Kansas, mainly in Montgomery County which was the principal sufferer. Along the Arkansas River the only losses reported were those of a small quantity of crops in the lower bottoms.

A moderate flood in the Trinity River of Texas from Dallas to a short distance below Trinidad was caused by very heavy rains on October 1, the 24-hour amounts ranging from 2 to a little more than 3 inches. Warnings were issued promptly and as result, there was no damage of consequence, while property valued at $6,500 was saved.

A decided rise in the lower Rio Grande, apparently coming from the San Juan River of Mexico was well forecast, and about $10,000 saved thereby to the people of the valley. Levees were strengthened, some excess water diverted through a flood-control outlet, and other precautionary measures taken.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
Atlantic drainage	*Feet*			*Feet*	
Lackawaxen, Hawley, Pa	9	19	19	10.1	19
Susquehanna:					
Oneonta, N. Y	12	20	20	12.5	20
Bainbridge, N. Y	11	20	21	12.0	21
Binghampton, N. Y	14	19	20	16.6	19
Towanda, Pa	16	20	20	17.3	20
Wilkes-Barre, Pa	20	20	21	25.6	21
Roanoke, Weldon, N. C	30	6	6	33.6	6
Mississippi drainage					
Stony Creek, Johnstown, Pa	10	20	20	12.0	20
Tippecanoe, Norway, Ind	6	2	2	6.5	2
		31	31	6.0	31
Illinois:					
Peru, Ill	14	3	21	14.9	4–5
Havana, Ill	14	7	22	15.3	15
Beardstown, Ill	14	6	26	17.0	12–14
Pearl, Ill	12	9	21	13.9	13–15
Grand:					
Gallatin, Mo	20	7	7	21.0	7
Chillicothe, Mo	18	3	3	18.7	3
Osage:					
Osceola, Mo	20	2	12	26.1	9
Warsaw, Mo	22	2	12	28.2	9
Tuscumbia, Mo	25	4	13	27.7	11
Arkansas:					
Webbers Falls, Okla	23	3	5	24.8	4
Fort Smith, Ark	22	4	6	24.7	4–5
Ozark, Ark	22	5	5	22.4	5
Dardanelle, Ark	20	4	7	23.2	6
Morrilton, Ark	20	5	8	22.0	6
Neosho:					
Le Roy, Kans	24	2	2	26.0	2
Iola, Kans	15	2	8	19.8	2
Oswego, Kans	17	3	8	24.0	7
Fort Gibson, Okla	22	3	5	24.8	4
Verdigris, Independence, Kans	30	2	5	46.0	3
North Canadian, Oklahoma City, Okla	12	1	1	15.1	1
Pettit Jean, Danville, Ark	20	3	5	21.7	4
White:					
Calico Rock, Ark	18	2	6	30.5	3
Batesville, Ark	23	3	7	22.8	4
Newport, Ark	26	5	8	28.0	7
Georgetown, Ark	22	10	10	22.0	10
Black:					
Black Rock, Ark	14	1	1	15.0	1
Corning, Ark	11	2	5	11.9	4
West Gulf drainage					
Trinity:					
Dallas, Tex	25	3	4	29.7	3
Trinidad, Tex	28	4	19	35.8	8
Little, Little River, Tex	30	2	3	43.3	2
Nueces, Cotulla, Tex	15	11	12	16.0	12

MEAN LAKE LEVELS DURING OCTOBER, 1927

By UNITED STATES LAKE SURVEY

[Detroit, Mich., November 3, 1927]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes[1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during October, 1927:	*Feet*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	602.73	579.10	571.32	246.00
Above or below—				
Mean stage of September, 1927	+0.03	−0.06	−0.36	−0.28
Mean stage of October, 1926	+1.10	+0.76	−0.39	+0.06
Average stage for October, last 10 years	+0.55	−0.74	−0.54	−0.45
Highest recorded October stage	−0.91	−3.94	−2.38	−2.82
Lowest recorded October stage	+1.34	+1.19	+0.72	+1.32
Average departure (since 1860) of the October level from the September level	−0.05	−0.23	−0.32	−0.34

[1] Lake St. Clair's level: In October, 1927, 574.12 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, OCTOBER, 1927

By J. B. KINCER

General summary.—During the first decade general precipitation in the interior States was unfavorable in delaying field operations, as the soil was too wet to work in many places. The rains were excessive and damaging in some sections and, as a result of soft ground, considerable corn was blown down. The moisture was helpful in other places, however, being especially beneficial in the southern Piedmont. The soil was too dry in parts of the northern and west-central Great Plains and in some other western areas, but in general the principal agricultural States were well supplied with moisture.

During the second decade the weather was more favorable for agricultural interests, with generous rains in the theretofore droughty Southeast very helpful in conditioning the soil, while cool, dry, sunshiny weather in the interior valleys favored small-grain seeding. Soil conditions continued good generally and, while the weather was cool over the eastern half of the country, frost damage was mostly small, with the first general killing frost of the season much later than usual in most sections.

The last decade was exceptionally favorable for farming operations, the abnormally warm weather, abundant sunshine, and low humidity being ideal for drying out the corn crop, and seasonal farm work made good progress quite generally east of the Rocky Mountains. All the principal crops had matured at the close of the month and there was no longer any danger of material frost damage. Rain was needed in the Southeast and locally in the Ohio Valley and central-western sections, but precipitation was beneficial generally in practically all southern and central districts from the Rocky Mountains westward.

Small grains.—During the first decade seeding made slow progress in much of the Wheat Belt due to continued rains and wet soil, but the grain that had been seeded came up generally to a good stand and was making fine growth. Dry, sunshiny weather during the second decade was more favorable for late seeding and this work made good advance, while the generally favorable condition of the soil promoted rapid growth of newly seeded grain. West of the Mississippi River seeding had been mostly accomplished and the early seeded grain made good progress. During the last decade winter wheat, on the whole, continued to made good advance, but the late-seeded needed rain in Ohio and more moisture would have been beneficial in some other sections of the Ohio Valley area; otherwise from the Mississippi Valley eastward the soil was mostly in fairly good condition. More rain was needed in the southern Great Plains, especially in the western third of Kansas where the soil had become dry. In the far West, timely rains occurred in California and the Great Basin.

Corn.—During the first decade, with the prevailing warm weather, corn matured rapidly from Ohio and Kentucky eastward and northeastward and the crop was mostly safe from frost east of the Appalachain Mountains. There was still considerable immature corn in the lower Ohio Valley, including Illinois, and also in eastern Iowa, but elsewhere throughout the country the crop was nearly all safe from frost. During the second decade the southern limit of killing frost advanced into the Corn Belt as far as northwestern and west-central Illinois, and generally over Iowa, about 10 days later than normal. The damage was not great, however, as more than 80 per cent of the crop in Iowa was safe before frost came, although there was considerable harm locally to unmatured fields. The dry, sunshiny weather that prevailed was very favorable in drying out the crop. During the last decade ideal conditions for drying out corn obtained in all sections east of the Rocky Mountains, and gathering and cribbing had begun quite generally. The weather was especially favorable in Iowa where early grain was safe to crib, with husking well begun in parts of the west. Husking progressed in the Plains States and some was accomplised in Illinois and Indiana.

Cotton.—During the first decade temperatures were seasonable to rather high in the Cotton Belt and rainfall was mostly moderate to heavy. East of the Mississippi River there was some slight interruption by rains to picking, but this work made generally good progress. West of the Mississippi Valley there was some lowering of grade due to rains. Progress of late cotton was good in Arkansas, but in Oklahoma general deterioration was reported and harvest was delayed by rains and wet soil. In Texas too much rain in places delayed picking, lowered grade, and beat out some staple, but gathering was well advanced, except in the northwest. During the second decade generally fair and sunny weather permitted good progress in picking and ginning in the eastern half of the belt and this work was well along. West of the Mississippi River the dry weather made generally excellent conditions for harvest with late bolls developing well in Arkansas and the crop opening rapidly; picking and ginning advanced well elsewhere in the western belt. During the last decade conditions were generally favorable for harvest in the eastern part of the belt, with this work well up in most sections. In Arkansas bolls continued to develop on the overflowed land and picking was well along generally. The weather favored rapid harvest in Oklahoma, while in Texas gathering was about completed, except in the northwest and extreme west.

Miscellaneous crops.—General progress of pastures was poor in some southeastern sections due to continued dry weather, but in most other eastern areas they did well generally. Moisture was needed in southern New Mexico, but in most western sections favorable conditions prevailed. Livestock did well generally during the month and were moving to winter quarters at the close.

The weather was mostly favorable for potato digging, with this work nearing completion in northern sections at the close of the month. Truck needed rain rather badly in some areas of the Southeast, but otherwise did well. Excellent weather for sugar cane prevailed in Louisiana and cutting and grinding were beginning in a few places at the end of the month. Sugar beet harvest progressed well. Citrus in Florida was unfavorably affected by dry weather and was coloring slowly, but conditions were favorable in California.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The weather over the North Atlantic during October was characterized by long periods of cyclonic activity on the steamer lanes, and also, to a lesser extent, in southern waters. Table 1 shows a large minus pressure departure at Horta, and on only two days during the month was the barometer reading at that station equal to or above the normal, while from the 3d to the 10th the readings ranged between 29.34 and 29.92 inches. On the other hand an area of high pressure was in the vicinity of the Bermudas from the 1st to 8th and the shifting of the North Atlantic high so far to the westward of its normal position was no doubt responsible in part for the freakish weather experienced over a large portion of the ocean.

During certain periods of the month low pressure prevailed over an extensive territory, while the storm areas were comparatively restricted. One shipmaster commented on the fact that while he recorded low-barometer readings for several successive days, only moderate winds were encountered during the period.

Judging from reports received the number of days with fog was not far from the normal over the greater part of the ocean, although slightly above over the eastern section of the steamer lanes and off the European coast.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, 8 a. m. (75th meridian time), North Atlantic Ocean, October, 1927*

Stations	Average pressure	Departure [1]	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Belle Isle, Newfoundland	[2] 29.82	−0.05	30.36	13th [3]	28.82	22d.
Halifax	30.00	−0.05	30.46	12th	29.00	21st.
Nantucket	29.97	−0.05	30.40	31st	29.14	20th.
Hatteras	30.01	−0.02	30.30	6th	29.52	19th.[3]
Key West	29.92	−0.06	30.04	23d	29.74	17th.
New Orleans	30.03	−0.02	30.22	14th	29.84	12th.
Cape Gracias	29.81	−0.00	29.90	23d [3]	29.66	17th.
Turks Island	29.96	−0.01	30.06	23d	29.80	17th.
Bermuda	30.06	−0.04	30.32	2d	29.64	19th.
Horta, Azores	29.87	−0.25	30.18	1st	29.34	6th.
Lerwick, Shetland Islands	29.81	−0.02	30.47	8th [3]	29.00	27th.
Valencia, Ireland	29.97	−0.06	30.47	12th	28.94	28th.
London	30.05	−0.14	30.48	5th	29.09	29th.

[1] From normals shown on H. O. Pilot Chart based on observations at Greenwich mean noon, or 7 a. m., 75th meridian time.
[2] Mean of 28 observations.
[3] And on other dates.

On the 1st three distinct areas of low pressure were over the northern section of the ocean; the first central near Belle Isle, the second near 50° N., 27° W., and the third over the Shetland Islands. On the 2d the western low was central near 52° N., 43° W., and the other two had evidently combined over the British Isles, where moderate to strong gales were reported at a number of land stations.

On the 2d a shallow depression was off the south coast of Florida. This moved northward, deepening gradually, and on the 4th the center was near Father Point. On the latter date Nantucket reported a southwest gale, force 10.

From the 4th until the 7th the region of the Azores was covered by an area of low pressure that reached its maximum intensity on the 6th, on which date, as well as the 7th, moderate to full gales were reported in the southwest quadrant. On the 8th the center of the low was near 45° N., 23° W., from which position it moved but slightly during the following three days, gradually filling in.

From the 12th to the 20th the Caribbean Sea was covered by a depression which reached its greatest intensity on the 17th when a barometer reading of 29.54 inches was recorded near the center, then lying between Jamaica and the Central American coast. At times the storm area extended into the Gulf of Mexico but ultimately appeared to move in a northeasterly direction as a poorly defined depression which dissipated after passing the Greater Antilles.

On the 13th a severe disturbance, although of limited extent, was central off the American coast near New York. Southerly gales prevailed from Hatteras to Portland, Me., and the storm area extended eastward to the 65th meridian. On the same day an area of high pressure had its crest near Cape Race, Newfoundland, where a barometer reading of 30.58 inches was recorded, and on the 13th and 14th northerly gales, accompanied by comparatively high pressure, occurred.

While the Caribbean depression was yet in existence, a disturbance formed off the southern Atlantic coast of the United States and moved northward, being central on the southern New England coast on the morning of the 19th as a storm of considerable intensity. Nantucket reported a pressure of 29.20 inches and fresh to strong gales prevailed between Cape Hatteras and Nova Scotia.

Prior to this time, on the 15th and 16th, a LOW of limited extent was central about 10° west of the Azores, and on the latter date a southeasterly wind of force 11 was reported in the northeast quadrant.

On the 24th and 25th a well-defined LOW was over the middle section of the steamer lanes, attended by moderate westerly gales in the southern quadrants.

On the 27th a well-defined and severe distubance was central near the Azores. On the following day the disturbance had moved to a position off southwest Ireland and deepened, Valencia reporting a barometer reading of 28.94 inches. By the morning of the 29th the center had reached the Norwegian coast, with strong winds and gales blowing over northwestern Europe. According to press dispatches this storm off the coast of Ireland was one of the most disastrous in years. The loss of life and property was very great, especially among the fishing fleets. Condition on the 28th are shown on Chart VIII. Conditions on the 29th to 31st are shown on Charts IX to XI. On the last-named date a storm area of wide extent covered the ocean.

NOTES.—American S. S. *President Garfield*, Capt. G. Cullen. Observer, E. A. Cooper. From Marseille to Boston.

Blow accompanied by rising barometer, until reaching its peak of 30.46 inches on October 14, in 42° 43′ N., 44° 54′ W., at 8 a. m., with a wind of NW. 6, after swinging from NW., 5–6, into N., 6 and back to NW., 6, finally blowing itself out.

American S. S. *Clontarf*, Capt. M. S. Laciar. Observer, Gilbert B. Wagner. From New York to Alexandria, Egypt.

October 14, during rain squall, waterspout observed. Approximate position, 34° 10′ N., 19° 14′ E.

October 15, during rain squall, waterspout observed in 31° 30′ N., 29° 13′ E.

OCEAN GALES AND STORMS, OCTOBER, 1927

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Western Ally, Am. S. S.	New York	Rotterdam	47 15 N.	35 17 W.	Oct. 1	10a., 1	Oct. 1	29.51	N	ENE., 9	ENE	ENE., 9	SW.-ENE.
Elzasier, Belg. S. S.	Antwerp	New York	50 45 N.	28 10 W.	1	2p., 1	1	29.46	E	NE., 9	N	N., 10	ENE.-NNE.
Anacortes, Am. S. S.	Glasgow	Baltimore	55 34 N.	8 24 W.	Sept. 30	—, 1	1	29.45	W	W	NW	—, 9	WSW.-WNW.
Wytheville, Am. S. S.	Rotterdam	New York	46 40 N.	47 49 W.	Oct. 1	4a., 2	1	29.50	NE	W., 5	W	SSW., 10	SSW.-W.-N.
Housatonic, Br. S. S.	Baytown	Avonmouth	51 30 N.	5 25 W.	2	8a., 2	2	29.65	SW	SW., 9	W	SW., 9	SW.-WSW.
Vesta, Am. S. S.	Beaumont	New York	32 22 N.	79 00 W.	2	Midt., 2	3	29.76	E	E., 8	S	E., 8	E.-SE.-S.
West Totant, Am. S. S.	New Orleans	London	44 40 N.	43 00 W.	3	2a., 3	4	29.80	NNW	NNW	NW	NNW., 10	Steady.
Dania, Dan. S. S.	Newcastle	Boston	43 00 N.	65 15 W.	4	10a., 4	4	29.65	S	S., 10	SE	SE., 10	S.-SE.
Liberty Land, Am. S. S.	Valencia, Spain.	New York	34 55 N.	29 20 W.	5	4a., 7	7	29.52	W	NW., 7	NW	NW., 8	W.-NW.
Eurana, Am. S. S.	Avonmouth	do	43 57 N.	28 26 W.	8	6a., 8	10	29.32	NW	S., 4	NW	—, 9	NW.-WNW.-NW.
Ventura de Larrinaga, Br. S. S.	Norfolk	Dublin	46 47 N.	32 54 W.	7	4a., 9	9	28.95	N	NNW	N	NNW., 11	Steady.
Blue Triangle, Am. S. S.	Alexandri	Boston	41 24 N.	25 10 W.	8	3a., 10	11	29.44	SSE	WSW., 9	N	NNW., 10	WSW.-W.-N.
Anverarder, Br. S. S.	Canal Zone	Glasgow	35 40 N.	48 30 W.	9	4p., 11	16	29.67	SSE	SW., 8	ESE	Var., 9	SSW.-NNW.
El Almirante, Am. S. S.	New Orleans	New York	32 00 N.	78 00 W.	12	4p., 12	13	29.80	S	S., 8	W	S., 10	S.-W.
Monterey, Am. S. S.	New York	Tampico	19 06 N.	93 43 W.	12	9p., 13	15	29.86	N	N., 7	N	N., 10	Steady.
Caucasier, Belg. S. S.	do	Antwerp	40 10 N.	41 25 W.	13	8a., 13	14	29.77	SE	SSE., 9	W	S., 10	SE.-S.-SSW.
Stuttgart, Ger. S. S.	do	Europe	47 05 N.	34 47 W.	13	8a., 14	14	29.95	NNE	NNE., 9	NE	NNE., 9	NNE.-NE.
Sinaloa, Hond. S. S.	Vera Cruz	New Orleans	19 50 N.	95 34 W.	15	Noon, 15	16	29.84	NW	NW., 8	NW	NW., 9	Steady.
Housatonic, Br. S. S.	Liverpool	Charleston	36 23 N.	37 08 W.	16	3a., 16	16	29.37	S	W., 9	N	W., 9	S.-W.-N.
Gulfprince, Am. S. S.	Port Arthur	Providence	38 30 N.	72 29 W.	18	6a., 18	19	29.56	ENE	ENE., 7	NE	NE., 8	Steady.
Oregonian, Am. S. S.	New York	Canal Zone	38 20 N.	73 37 W.	20	Noon, 20	21	29.31	NW	NW	WNW	NW., 9	Do.
Ossa, Am. S. S.	do	Genoa	41 26 N.	55 05 W.	19	8p., 20	21	29.54	SSE	ESE	SE	SSE., 10	SSE.-SE.
Bannack, Am. S. S.	Dublin	Baltimore	44 10 N.	60 20 W.	21	3p., 21	23	28.99	SW	W., 7	NW	W., 9	S.-SW.-NW.
Bellhaven, Am. S. S.	Cardiff	do	37 14 N.	58 50 W.	21	—, 21	23	29.49	W	W., 9	NW	WNW., 9	Steady.
Caronia, Br. S. S.	Havre	New York	41 42 N.	59 50 W.	21	2a., 22	23	29.23	WSW	W., 8	WNW	W., 9	Do.
Galtymore, Br. S. S.	Liverpool	Boston	50 12 N.	42 00 W.	21	4a., 22	22	29.12	SE	SW., 9	SW	SSE., 10	SSE.-SW.
München, Ger. S. S.	Bremerhaven	New York	51 10 N.	14 12 W.	21	9a., 22	22	29.37	WSW	NNW., 7	N	NNW., 10	NNW.-N.-NW.
Conte Rosso, Ital. S. S.	Naples	do	37 44 N.	56 03 W.	22	1a., 23	23	29.58	WSW	W., 8	W	WSW., 9	Steady.
Stockholm, Swed. S. S.	Gothenburg	do	51 30 N.	42 18 W.	23	10p., 23	23	28.77	W	W., 7	NW	W., 9	W.-NW.
Spar, Du. S. S.	Montreal	Bremen	59 25 N.	24 34 W.	23	7a., 24	24	28.84	E	E., 10	S	E., 10	E.-S.
Albert Ballin, Ger. S. S.	Southampton	New York	49 30 N.	20 00 W.	24	11p., 24	26	29.39	SSW	SW., 10	N	SW., 10	SSW.-N.
Mirach, Du. S. S.	Rotterdam	Montreal	53 28 N.	40 41 W.	22	4a., 25	26	28.75	S	WNW	NNW	NNW., 9	
Mercier, Belg. S. S.	Antwerp	New York	50 20 N.	18 27 W.	26	4p., 26	26	29.24	SW	SW., 11	NW	SW., 11	SW.-W.-NW.
Albert Ballin, Ger. S. S.	Southampton	do	45 25 N.	44 50 W.	27	8p., 27	28	29.50	SW	W., 10	NW	NW., 10	WSW.-WNW.
Breda, Du. S. S.	Amsterdam	Canal Zone	40 28 N.	28 33 W.	26	2p., 27	27	29.47	SW	SW., 10	NW	SW., 10	S.-SW.-NNW.
Mercier, Belg. S. S.	Antwerp	New York	49 38 N.	30 51 W.	28	4p., 28	29	29.38	E	E., 10	NE	NE., 11	E.-NE.
W. S. Rheem, Am. S. S.	Canal Zone	London	48 12 N.	16 05 W.	28	7a., 28	28	28.99	S	NW., 12	W	NW., 12	WSW.-NW.
De Grasse, Fr. S. S.	Havre	New York	50 42 N.	14 24 W.	27	11a., 28	28	28.87	S	SSW	WNW	WNW., 11	SSW.-WNW.
West Cohas, Am. S. S.	Manchester	Beaumont	41 50 N.	26 55 W.	27	1p., 28	29	29.13	SW	SW., 9	SSW	—, 10	
Sinaia, Fr. S. S.	Lisbon	Providence	38 09 N.	44 32 W.	29	6p., 29	31	29.33	SW	SSE., 6	NNW	S., 10	
Adra, Br. S. S.	Sydney, Nova Scotia.	Hull	50 00 N.	18 00 W.	29	11a., 29	30	29.57	SW	SW., 10	SW	SW., 10	Steady.
Persephone, Dan. M. S.	Hamburg	New York	45 30 N.	43 19 W.	30	Noon, 30	Nov. 1	28.96	E	NE., 7	NW	N., 10	E.-N.-NNW.
Nevada, Dan. S. S.	Montreal	Copenhagen	58 58 N.	20 30 W.	30	10a., 30	2	28.53	ESE	ESE., 8	WSW	WSW., 10	Steady.
Trimountain, Am. S. S.	Amsterdam	New Orleans	48 42 N.	9 13 W.	28	Noon, 30	1	29.58	SW	SW., 8	SW	SW., 10	Do.
Matinicock, Am. S. S.	Tampico	Baltimore	31 10 N.	79 00 W.	31	4p., 31	2	30.01	E	E		—, 9	SE.-NE.-N.
Sagaporack, Am. S. S.	Gothenburg	Boston	50 37 N.	47 50 W.	30	10a., 31	1	29.17	N	NW	NW	NNW., 10	N.-NNW.
Bristol City, Br. S. S.	Bristol	Philadelphia	48 27 N.	34 20 W.	31	7a., 31	1	28.75	SW	SW., 8	NW	SW., 9	Steady.
Steel Seafarer, Am. S. S.	Port Said	New York	37 47 N.	33 08 W.	30	7a., 31	Oct. 31	29.29	S	NW., 5	S	S., 11	S.-W.-NW.
West Totant, Am. S. S.	London	Tampa	40 12 N.	26 45 W.	31	6a., 31	Nov. 1	29.42	S	SSW	SSW	S., 10	Steady.
NORTH PACIFIC OCEAN													
Emp. of Asia, Br. S. S.	Victoria	Yokohama	42 47 N.	151 45 E.	Oct. 1	10a., 1	Oct. 1	29.38	NE	NE., 7	N	NNE., 8	SSW.-NE.
Akibasan Maru, Jap. S. S.	Anacortes	do	51 10 N.	173 02 W.	1	5p., 2	2	30.03	SSE	SSE., 8		SSE., 9	SSE.-WNW.
Antietam, Am. S. S.	Japan	San Pedro	41 20 N.	174 14 E.	1	3p., 2	3	29.66	S	SSW	SE	—, 8	S.-SSW.
Kinkasan Maru, Jap. S. S.	Miike	Coos Bay	46 50 N.	134 20 W.	2	8p., 2	3	29.86	WNW		N	NNW., 8	WNW.-N.
Shinyo Maru, Jap. S. S.	Yokohama	San Francisco	35 00 N.	151 00 E.	3	1a., 3	3	29.26	E	S., 12	WSW	SW., 12	4 pts.
Paris Maru, Jap. S. S.	Vancouver	Yokohama	52 13 N.	142 09 W.	8	4p., 9	10	29.58	W	WSW., 8	W	W., 9	
West Prospect, Am. S. S.	San Francisco	Shanghai	33 00 N.	149 55 E.	9	4p., 9	10	29.77	SSW	SSW., 8	SW	SW., 9	SSW.-SW.
Protesilaus, Br. S. S.	Victoria	Yokohama	42 31 N.	160 51 E.	9	1p., 10	11	29.07	ESE	Var., 2	WNW	NW., 10	Var.-NW.
West Hixton, Am. S. S.	Astoria	Yokkaichi	45 40 N.	157 40 E.	10	2a., 11	11	29.15	ESE	SSW., 8	SW	ESE., 9	ESE.-WSW.
Tamaha, Br. S. S.	Hong Kong	San Pedro	41 14 N.	144 25 W.	13		13	29.43	S	S., 7	WSW	—, 10	S.-WSW.
Akagisan Maru, Jap. S. S.	Yokohama	San Francisco	44 45 N.	146 00 W.	12	4p., 16	17	28.78	SW	NW., 11	NW	NW., 11	SW.-NNW.
Eldridge, Am. S. S.	Puget Sound	North China	46 10 N.	157 26 E.	13	8a., 13	14	29.34	WSW	WSW., 8	W	WSW., 9	WSW.-W.
Hakutatsu Maru, Jap. S. S.	Muroran	Columbia River.	51 08 N.	158 04 W.	13	4p., 13	15	29.08	NE	NE., 8	W	NW., 9	NE.-NW.
Pres. Jefferson, Am. S. S.	Seattle	Yokohama	52 05 N.	144 25 W.	18	8a., 14	16	28.25	S	SW., 9	NW	W., 11	SW.-W.
Elkridge, Am. S. S.	Otaru	San Francisco	43 00 N.	135 45 W.	14	4p., 14	15	29.35	SSW	SSW., 8	WSW	SE., 9	SSW.-WSW.
Emp. of Asia, Br. S. S.	Vancouver	Yokohama	49 27 N.	129 13 W.	14	8a., 14	16	29.80	SE	SE., 7	SE	S., 9	SE.-SW.
Kohnan Maru, Jap. S. S.	Miike	Coos Bay	48 58 N.	147 18 W.	13	4a., 14	17	28.59	SW	SW., 7	SSW	—, 10	SSW.-WSW.
Makaweli, Am. S. S.	Port Angeles	Honolulu	40 16 N.	138 30 W.	14	6p., 16	17	29.40	S	SW., 11	WNW	SW., 11	S.-SW.
Mana, Am. S. S.	Astoria	do	42 08 N.	132 47 W.	16	2a., 17	17	29.42	S	S., 10	SW	S., 10	Do.
West Holbrook, Am. S. S.	Yokohama	Portland	47 19 N.	127 20 W.	17	Noon, 17	17	29.51	SSE	SE., 9	SSE	SE., 10	Steady.
Pacific, Am. S. S.	Everett	Balboa	15 05 N.	95 35 W.	18	10p., 18	19	29.81	NE	NE., 7	NE	NE., 9	Do.
Emp. of Asia, Br. S. S.	Vancouver	Yokohama	51 15 N.	174 13 W.	18	4p., 18	20	28.26	NE	SE., 10	SW	SW., 10	SE.-SW.
City of Victoria, Br. S. S.	Japan	Victoria	45 40 N.	160 30 E.	18	6a., 19	20	29.07	WNW	NW., 7	NW	W., 10	NW.-W.
Hayo Maru, Jap. S. S.	Muroran	Vancouver	44 32 N.	150 14 E.	18	4p., 18	20	29.64	NW	NW., 5	NW	WNW., 9	Steady.
Pres. Jefferson, Am. S. S.	Seattle	Yokohama	50 00 N.	176 25 E.	19	8p., 19	20	28.07	ESE	ESE., 9	NNW	NNW., 12	
West Elcajon, Am. S. S.	Hong Kong	San Francisco	46 46 N.	176 10 E.	18	3p., 18	21	28.33	S	S., 9	WNW	WSW., 11	Do.
Hakushika Maru, Jap. S. S.	Nagasaki	Grays Harbor.	48 42 N.	177 10 W.	18	—, 19	21	28.45	E	SW., 10	WNW	SW., 11	
Kohshun Maru, Jap. S. S.	Otaru	Coos Bay	49 35 N.	164 35 E.	18	9a., 19	21	28.56	WSW	WNW., 10	NNW	WNW., 10	
Iwatesan Maru, Jap. S. S.	Yokohama	San Francisco	45 56 N.	161 00 W.	19	4p., 20	22	29.21	W	SW., 10	W	SW., 11	SW.-W.
West Himrod, Am. S. S.	do	Seattle	50 18 N.	155 30 W.	21	2a., 21	23	28.78	SW	SW., 7	W	W., 10	Steady.
Lurline, Am. S. S.	Seattle	Honolulu	43 00 N.	134 00 W.	24	8p., 24	26	29.61	NE	NE., 8	NW	NW., 9	NE.-N.
Lubrico, Am. S. S.	Honolulu	San Francisco	32 35 N.	135 47 W.	25	5p., 25	26	29.61	NW	NW., 9	NW	NW., 10	Steady.
West Nomentum, Am. S. S.	Davao	Columbia River.	41 00 N.	168 25 E.	25	3p., 26	28	29.17	SE	SE., 9	W	SE., 11	Do.
Gyokoh Maru, Jap. S. S.	Aioi, Japan	Coos Bay	47 09 N.	166 47 E.	27	5p., 28	28	28.98	ESE	NNE., 9	E	NNE., 9	8 pts.
Pres. Grant, Am. S. S.	San Francisco	Yokohama	30 00 N.	150 42 E.	29		29	29.13	N	N., 10	NE	NE., 12	N.-NE.

Ocean gales and storms, October, 1927—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH PACIFIC OCEAN—Continued			° ′	° ′				Inches					
Steel Mariner, Am. S. S.	Kobe	Port Townsend.	47 50 N.	172 15 W.	25	Noon, 30	31	29.04	ENE	NNE	WNW	N., 9	NE.-N.
Columbia Maru, Jap. S. S.	Yokohama	Seattle	42 30 N.	158 21 E.	27	6a., 29	Nov. 1	29.48	NW	NNE	NNW	NNE., 8	1 pt.
Mayebashi Maru, Jap. S. S.	do	San Francisco	46 02 N.	146 53 W.	29	5p., 31	1	29.45	E	SW., 7	W	SE., 8	SW.-WSW.
SOUTH PACIFIC OCEAN													
Sonoma, Am. S. S.	San Francisco	Sydney	30 20 S.	158 32 E.	5	8a., 5	Oct. 5	29.70	SSW	SSW., 6	S	SSW., 11	Steady.
San Nazario, Br. S. S.	Buenos Aires	San Pedro	52 28 S.	70 10 W.	10	8a., 11	12	29.48	NW	WNW., 9	W	WNW., 10	WNW.-SW.
SOUTH ATLANTIC OCEAN													
San Nazario, Br. S. S.	Buenos Aires.	San Pedro	47 00 S.	63 55 W.	7	4a., 8	8	29.39	N	WNW	WNW	N., 8	

NORTH PACIFIC OCEAN

By Willis E. Hurd

Strong wintry conditions visited the upper latitudes of the North Pacific Ocean in October, 1927. Snow and hail squalls occurred over the lower waters of the Gulf of Alaska on the 14th and 15th, and exceptionally stormy weather prevailed north of the 40th parallel during a full third of the month. A glance at the "Gale and storm report" will show that heavy weather in the Temperate Zone began in earnest about the 8th, rose to a peak on the 19th to 21st, then declined somewhat until the 26th, after which, except for an isolated tropical gale, the ocean experienced comparative quiet. From the 14th to the 21st, and on the 26th, full storm to hurricane winds were encountered over great areas between the 135th meridian of west longitude and the 160th meridian east. On the 20th and 21st, the days of most widespread storm violence, the gale-swept region stretched south of the Aleutian Islands for a latitudinal width of more than 500 miles, between longitudes 155° W. and 170° E. In addition, on the 3d and 29th, hurricane velocities from typhoons were elsewhere experienced. Thus, in all, winds in excess of force 10 are known to have occurred on 11 days this month on the open waters of the Pacific. Gales of force 8 to 10 were further experienced by vessels somewhere in the ocean on most other dates, except the 4th to the 7th, which was a period of quiet.

Barometric pressures on the average were not abnormally low for the month except in the Gulf of Alaska, where the principal concentration of the Aleutian cyclone lay, with minor fluctuations, from the 6th until the 28th. The mean pressure at Kodiak, the center of the disturbance, was 29.39 inches, which is 0.20 inch below the normal. The lowest daily reading here was 28.14 inches, on the 14th, on which date and the one following occurred the strongest gales in the gulf. On the 16th and 17th a center secondary to the main low formed near 40° to 45° N., 135° to 140° W., and on both dates this position was near the scene of wind forces rising to 11 and 12. On the 18th to 21st pressures, in addition to being low over the Alaskan Gulf, were very low far to the westward, where an intense cyclone had developed and was traveling eastward toward the primary storm center. It was on the 19th, in the midst of the violent gales of this storm—then definitely joining the low to the eastward—that the American Steamer *President Jefferson*, in 50° N., 176° 25′ E., reported a pressure reading of 28.07 inches, which was the lowest for the month in connection with an extratropical storm.

Cyclonic offshoots from the low in the gulf entered the American Continent on the 6th, 8th, 12th, 16th, 18th, 20th, 23d, and 28th.

Owing to the considerable cyclonic activity in middle and higher latitudes, the North Pacific high was well developed only during the first few days and a part of the last decade of the month, being pushed to the southeastward and partly disintegrated during much of the intervening time. From the 24th to the 27th it was pushed back from the California coast by an intruding offshoot of the northern cyclone which had forced its way southward. The offshoot, however, became disconnected from the parent low, although it developed sufficiently to cause gales of maximum force 10 along the eastern half of the San Francisco-Honolulu route on the 25th and 26th.

Pressure data for several island and coast stations in west longitudes are given in the following table:

Table 1.—*Averages, departures, and extremes of atmospheric pressure at sea level at indicated hours, North Pacific Ocean, October, 1927*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	Inch	Inches		Inches	
Dutch Harbor [1] [2]	29.70	+0.01	30.42	1st	28.76	20th.
St. Paul [2]	29.71	+0.05	30.18	26th	28.94	7th.
Kodiak [1] [3]	29.39	−0.20	30.36	3d	28.14	14th.
Midway [1] [2]	29.95	−0.10	30.22	14th [5]	29.74	29th.
Honolulu [3]	30.03	+0.03	30.15	28th	29.66	1st.
Juneau [3]	29.69	−0.18	30.24	2d	28.90	15th.
Tatoosh Island [3] [4]	29.97	−0.06	30.35	7th	29.48	16th.
San Francisco [3] [4]	29.97	−0.03	30.15	29th	29.72	31st.
San Diego [3] [4]	29.93	0.00	30.10	29th	29.70	31st.

[1] For 30 days. [2] P. m. observations only. [3] A. m. and p. m. observations.
[4] Corrected to 24-hour mean. [5] On other dates.

Several typhoons occurred in the Far East during October. These are discussed in the immediately following article by Rev. José Coronas, of the Philippine Weather Bureau, and it is necessary to supplement his report by only a few additional facts. The "first Pacific typhoon," noted as moving E. by N. on October 1,

seems to have attained great violence on the 2d and 3d. The Japanese steamer *Shinyo Maru* encountered a southwest wind, force 12, lowest pressure 29.26 inches, in connection with this storm on the early morning of the 3d, in 33° N., 151° E., and reported receiving a typhoon warning which had been issued at 6 p. m. of the 2d by the Tokyo Observatory to the effect that the storm center was then located at 33° N., 154° E., lowest pressure 27.95 inches.

Father Coronas notes the "third Pacific typhoon" as being north of the Bonins (Ogasawara) at noon of the 28th. Further information given by the American steamer *President Grant* shows that the storm continued to the eastward and on the 29th was blowing a northeast hurricane in 30° N., 150° 42′ E., lowest observed pressure, 29.13 inches.

One depression is noted on the Mexican weather maps as appearing off the Mexican coast south of Acapulco on the 19th and 20th. The wind circulation near 15° N., 100° to 105° W., was cyclonic, and the seas were heavy and confused, but no gales were reported there by our observers. Strong northeast gales of the norther type, however, occurred on the 18th in the Gulf of Tehuantepec, as well as northeast winds of force 7 on the 19th.

At Honolulu trade winds prevailed except on the 19th, when there was a mild kona. The prevailing direction here was from the east, and the maximum velocity, 28 miles from the east, on the 24th.

Fog decreased somewhat in northern waters since September, but was reported to have been observed on from 1 to 3 days in the several 5-degree squares between the central Aleutians and the Kuril Islands. It occurred on about 15 per cent of the days over the area east of 150° W., between the 45th and 50th parallels. Some 30 to 40 per cent of fog formed off the central California coast, and 30 per cent southward to the 30th parallel. Less than 20 per cent was reported from Washington and Oregon coast waters.

TYPHOONS AND DEPRESSIONS

FIVE TYPHOONS OVER THE FAR EAST IN OCTOBER, 1927

By Rev. JOSÉ CORONAS, S. J.

[Weather Bureau, Manila, P. I.]

There have been two well-developed typhoons over the Philippines, and three other distant typhoons over the Pacific during this month of October.

Typhoon of the Visayas, October 5.—This typhoon was shown for the first time in our weather maps on October 1 to the southwest of Guam near 142° longitude E., and 11° latitude N. It moved almost due west, with a very light inclination to the north, until it reached the eastern coast of Samar close to Borongan at 11 p. m. of the 4th, the barometric reading at Borongan being then 744.84 mm. (29.32 inches). The direction of the typhoon from Samar to the north of Capiz was practically west.

The approximate position of the center at 6 a. m. of the 2d to 5th was as follows:

October 2, 6 a. m., 140° 10′ longitude E. 10° 45′ latitude N.
October 3, 6 a. m., 135° 00′ longitude E. 11° 00′ latitude N.
October 4, 6 a. m., 129° 30′ longitude E. 11° 20′ latitude N.
October 5, 6 a. m., 123° 30′ longitude E., 11° 55′ latitude N.

From the north of Capiz there was an inclination of the track to WNW., and the center passed near to the north of Tourane, Indo-China, in the afternoon of October 7.

Considerable damage was done by this storm in the Provinces of Samar, Masbate, Capiz, Iloilo, and Romblon. Some small boats were wrecked to the north of Capiz with a good number of victims.

Typhoon of southern Luzon, October 9.—The first part of the track of this typhoon is at present rather indefinite owing to lack of observation from Yap, Western Carolines. It would seem that it was formed on October 4 to 6 to the south of Guam near 145° longitude E. and 9° latitude N. It probably moved WNW, on the 6th, 7th, and morning of the 8th. In the afternoon it took a decidedly westerly direction and touched the northernmost coast of Camarines Norte in the morning of the 9th. At 2 p. m. the center was situated over the coast of Luzon practically to the east of Manila, very near Infanta, and passed close to the south of Manila at about 4 p. m. of the same day. An inclination of the track to WNW. was noticed after 6 a. m. of the 10th in the China Sea. The center reached Indo-China at about 4 p. m. of the 11th.

Some damage was done also by this typhoon in the Provinces of Camarines Norte, Laguna, and Rizal.

The approximate position of the typhoon at 6 a. m. of the 8th to 11th was as follows:

October 8, 6 a. m., 132° 40′ longitude E., 13° 00′ latitude N.
October 9, 6 a. m., 122° 50′ longitude E., 14° 25′ latitude N.
October 10, 6 a. m., 117° 15′ longitude E., 14° 35′ latitude N.
October 11, 6 a. m., 110° 50′ longitude E., 16° 40′ latitude N.

Three other distant typhoons over the Pacific.—The first of these typhoons appeared to the west of the Bonins in the early morning of October 1, and at noon the center was passing close to the north of said islands with a barometric reading 742.5 mm. (29.23 inches). The typhoon was moving E. by N.

The second Pacific typhoon was shown by our weather maps of the 13th to the east of Guam near 150° longitude E. and 13° latitude N. It moved NNW. on the 13th, and NW. on the 14th and 15th. In the afternoon of the 16th it recurved northeastward near 143° longitude E. and 21° latitude N.

The third Pacific typhoon was probably formed to the southeast of Guam on October 19. It moved WNW. until the 24th, when it inclined decidedly to the north near 130° longitude E. and 14° latitude N. It continued moving practically to the north until noon of the 27th, when it recurved to ENE. near 130° longitude E. and 25° latitude N. The center passed not very far to the north of the Bonins at noon of the 28th.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation, by sections, October, 1927

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	67.8	+3.4	Citronelle	98	5	2 stations	29	[2] 18	2.01	−0.61	Oneonta	4.78	Tuskegee	0.25
Arizona	63.7	+1.2	Camel Back	107	15	Bright Angel	18	[2] 1	0.64	−0.30	Bright Angel	3.77	4 stations	0.00
Arkansas	66.0	+3.8	Dumas	100	26	2 stations	30	[2] 13	3.13	+0.16	Dutton	8.25	Portland	0.82
California	61.5	+1.0	Greenland Ranch	110	17	Ellery Lake	12	28	2.16	+0.94	Fordyce Dam	6.31	Greenland Ranch	0.00
Colorado	48.4	+1.9	Lamar	93	4	Crested Butte	−5	23	0.71	−0.59	Steamboat Springs	3.18	Hartsel	0.00
Florida	73.8	+0.8	Moore Haven	98	3	Vernon	34	10	3.78	−0.61	Long Key	11.23	Lake City	0.04
Georgia	67.7	+3.1	3 stations	98	[2] 4	Clayton	27	[2] 14	1.78	−0.98	Toccoa	5.00	Goat Rock	T.
Idaho	48.5	+1.8	Chattin's Flat	97	15	Obsidian	1	31	1.71	+0.31	Roland	5.57	Deer Flat	0.43
Illinois	59.3	+4.1	2 stations	92	[2] 6	Lincoln	26	19	3.76	+1.14	La Harpe	7.33	Du Quoin	1.45
Indiana	58.6	+4.1	Vincennes	91	6	3 stations	28	[2] 15	2.55	−0.14	Covington	4.88	Princeton	0.32
Iowa	55.5	+3.6	Denison	91	22	Decorah	24	14	3.25	+0.83	Burlington	8.51	Washta	0.46
Kansas	60.6	+3.6	Oketo	95	24	Oberlin	26	9	1.78	0.00	Pleasanton	8.22	2 stations	T.
Kentucky	60.7	+2.7	5 stations	92	[2] 1	Farmers	27	17	2.61	+0.01	Hopkinsville	5.79	Williamsburg	0.60
Louisiana	70.4	+2.4	Lake Arthur	96	5	2 stations	32	10	2.78	−0.52	Schriever	7.76	Lake Providence	0.66
Maryland-Delaware	58.7	+2.4	Western Port, Md.	98	1	Oakland, Md.	24	[2] 16	5.88	+3.02	Chewsville, Md.	10.63	Mechanicsville, Md.	3.10
Michigan	52.4	+3.6	Monroe	92	2	Humboldt	18	18	2.59	−0.10	Whitefish Point	5.18	Mount Pleasant	0.35
Minnesota	48.8	+3.1	Chatfield	93	[2] 26	Meadowlands	18	9	1.61	−0.23	Baudette	3.37	Brainerd	0.56
Mississippi	68.0	+3.0	Tupelo	98	5	Duck Hill	29	20	2.46	−0.30	Kosciusko	6.19	Grenada	0.70
Missouri	60.9	+3.5	Dean	93	23	Goodland	26	19	4.72	+1.97	Kirksville	10.50	Sikeston	1.49
Montana	47.6	+3.3	Foster	92	16	Conway's Ranch	6	31	1.22	+0.21	Haugan	5.56	Crow Agency	0.00
Nebraska	55.7	+4.8	Alma	101	22	2 stations	20	[2] 8	0.62	−0.94	Falls City	3.91	4 stations	0.00
Nevada	53.2	+2.0	Las Vegas	95	[2] 15	Rye Patch	5	7	1.17	+0.56	Sharp	4.98	Mina	0.40
New England	52.5	+3.1	Waterbury, Conn.	94	2	Garfield, Vt.	17	30	5.40	+1.81	Greenville, Me.	9.11	Nantucket, Mass.	1.91
New Jersey	56.8	+1.8	2 stations	94	2	Runyon	23	31	7.82	+4.10	Tuckerton	14.07	Cape May City	2.31
New Mexico	54.3	+0.9	Boaz	96	[2] 5	Elizabethtown	10	8	0.25	−0.95	Bellview	1.74	22 stations	0.00
New York	53.1	+3.2	Addison	90	2	2 stations	18	30	5.84	+2.62	Scarsdale	9.72	2 stations	2.68
North Carolina	62.1	+1.9	Henderson	94	1	Mount Mitchell	17	18	3.96	+0.73	Randleman	8.10	Willard	1.31
North Dakota	47.0	+3.2	Bismarck	88	10	2 stations	12	13	1.30	+0.30	Towner	3.30	New England	0.16
Ohio	57.2	+3.4	Middleport	94	1	do	26	[2] 15	1.66	−1.06	Miamisburg	4.30	Danbury	0.71
Oklahoma	65.3	+3.7	Hollis	98	25	Kenton	22	12	2.84	−0.29	Webbers Falls	8.53	Supply	0.04
Oregon	51.2	+0.8	Echo	89	18	Fremont	5	31	2.20	−0.08	Astoria	10.98	Madras	0.34
Pennsylvania	55.6	+3.2	Carlisle	99	1	Gouldsboro	21	30	6.40	+3.22	Paupack	11.91	Sharon	1.58
South Carolina	65.8	+2.2	2 stations	93	[2] 4	Walhalla	32	18	3.25	+0.28	Camden	7.47	Aiken	0.49
South Dakota	52.6	+3.9	Marion	96	21	3 stations	17	8	0.93	−0.43	Eales	2.45	Cottonwood	T.
Tennessee	62.3	+2.9	Sevierville	95	2	Perryville	24	19	2.74	−0.03	Clarksville	7.08	Cressville	0.43
Texas	69.7	+2.2	Ricardo	101	[2] 2	Romero	23	12	3.11	+0.52	Encinal	10.90	7 stations	0.00
Utah	51.0	+2.1	St. George	94	16	2 stations	9	[2] 6	1.30	+0.14	Hurricane	3.06	Manila	0.05
Virginia	59.7	+2.6	Winchester	99	1	Burkes Garden	21	15	4.67	+1.71	Mount Weather	11.84	Damascus	1.00
Washington	49.4	+0.3	Dayton	83	16	Stockdill Ranch	12	31	4.29	+1.18	Forks	17.93	Lind (near)	0.60
West Virginia	57.0	+2.1	Moorefield	100	1	Bayard	21	26	4.13	+1.03	Harpers Ferry	11.10	Dam 26, Ohio River	1.14
Wisconsin	50.4	+2.4	Kilbourn	87	26	Long Lake	11	18	2.94	+0.39	Brodhead	6.62	Long Lake	0.75
Wyoming	46.3	+2.8	Buffalo	89	19	Riverside	−5	31	1.06	−0.13	Encampment	3.41	2 stations	0.00
Alaska (September)	45.5	−1.2	Hydaburg	81	19	2 stations	11	[2] 17	7.33	+0.12	Porcupine Creek	22.77	St. Michael	0.19
Hawaii	74.2	+0.8	2 stations	92	[2] 1	Volcano Observatory	51	27	3.65	−2.33	Olokele (Mauka)	24.70	7 stations	0.00
Porto Rico	79.2	+1.0	do	98	[2] 1	Aibonito	52	[2] 11	12.27	+3.96	Maricao	28.85	Mona Island	0.91

[1] For description of tables and charts, see REVIEW, January, 1927, p. 43.

[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, October, 1927*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							54.4	+3.4										79	4.21	+0.6										4.6		
Eastport	76	67	85	29.84	29.93	−.07	49.8	+2.3	75	1	56	31	31	44	19	46	43	79	7.05	+3.2	14	8,704	nw.	50	ne.	19	4	8	19	7.5	0.0	0.0
Greenville, Me.	1,070	6	----	28.78	29.95	----	47.1	----	72	6	55	21	31	39	32	----	----	----	9.11	----	12	5,754	nw.	29	----	22	7	8	16	----	0.0	0.0
Portland, Me.	103	82	117	29.86	29.98	−.06	53.0	+3.1	85	1	60	33	31	46	28	48	44	76	2.85	−0.8	9	6,487	n.	47	s.	13	15	7	9	4.8	0.0	0.0
Concord	289	70	79	29.64	29.96	−.09	52.2	+2.5	86	1	64	25	31	41	44	----	----	----	3.43	+0.2	9	3,965	nw.	25	nw.	22	14	7	10	5.0	0.0	0.0
Burlington	403	11	48	29.52	29.96	−.08	51.0	+1.8	80	3	59	29	11	43	28	----	----	----	4.56	+1.4	10	7,997	s.	50	s.	12	6	8	17	6.6	0.0	0.0
Northfield	876	12	60	----	29.99	−.05	48.8	+3.3	79	1	60	22	30	38	40	----	----	86	5.64	+3.2	11	5,212	s.	38	s.	12	5	14	12	6.2	0.0	0.0
Boston	125	115	188	29.83	29.96	−.09	57.9	+4.3	89	1	66	36	30	49	33	51	48	76	3.77	−0.1	8	7,173	sw.	41	se.	13	16	11	4	4.0	0.0	0.0
Nantucket	12	14	90	29.95	29.96	−.09	57.4	+3.2	77	2	64	40	30	51	19	53	50	82	1.91	−1.5	6	12,090	sw.	68	sw.	4	14	12	5	3.9	0.0	0.0
Block Island	26	11	46	29.94	29.97	−.08	57.5	+2.6	77	2	62	39	30	52	14	54	51	82	4.87	+0.8	8	13,732	w.	56	s.	4	21	2	8	3.0	0.0	0.0
Providence	160	215	251	29.80	29.97	−.08	56.9	+4.7	87	1	66	33	31	48	29	51	46	74	4.18	+0.3	9	9,447	nw.	56	nw.	21	21	5	5	2.9	0.0	0.0
Hartford	159	122	----	29.81	29.99	−.07	56.8	+5.6	91	2	66	31	31	47	30	----	----	----	4.14	+0.3	11	----	s.	----	----	----	20	5	6	3.1	0.0	0.0
New Haven	106	74	153	29.87	29.99	−.07	57.3	+3.5	86	2	66	33	31	48	29	51	47	76	3.88	0.0	9	7,001	sw.	52	se.	13	19	7	5	3.6	0.0	0.0
Middle Atlantic States							58.9	+2.6										78	6.09	+2.8										4.1		
Albany	97	102	115	29.88	29.98	−.08	55.6	+3.5	90	1	64	33	31	47	29	50	46	78	5.60	+2.6	8	5,206	s.	38	s.	12	16	11	4	3.9	0.0	0.0
Binghamton	871	10	84	29.06	30.00	−.06	54.2	+4.2	92	2	65	28	30	43	42	----	----	----	7.98	+4.9	10	3,837	e.	32	se.	12	12	8	11	5.1	0.0	0.0
New York	314	414	454	29.66	29.99	−.07	58.7	+2.4	87	2	66	42	30	52	24	52	48	73	8.82	+5.1	10	12,261	nw.	72	s.	13	16	8	7	4.1	0.0	0.0
Harrisburg	374	94	104	29.62	30.03	−.05	57.4	+2.6	90	1	67	38	26	48	33	51	48	77	7.78	+4.8	11	4,552	w.	35	se.	12	15	7	9	4.4	0.0	0.0
Philadelphia	114	123	182	29.88	30.01	−.06	60.4	+2.6	89	1	68	45	15	53	24	53	49	73	5.71	+2.6	10	6,677	sw.	40	n.	4	18	3	10	3.8	0.0	0.0
Reading	325	81	98	29.65	30.01	----	58.2	----	89	2	68	38	16	49	31	52	48	78	4.61	+1.4	11	4,069	n.	26	s.	12	17	6	8	4.1	0.0	0.0
Scranton	805	111	119	29.15	30.01	−.06	55.1	+3.2	91	2	65	33	30	45	34	50	48	86	9.16	+6.2	11	4,868	n.	30	se.	12	11	7	13	5.2	0.0	0.0
Atlantic City	52	37	172	29.94	30.00	−.07	59.2	+2.3	80	1	65	45	15	53	24	56	53	81	7.66	+4.4	11	13,409	w.	72	se.	4	18	6	7	3.7	0.0	0.0
Cape May	17	13	49	----	----	----	60.5	+0.9	83	1	69	42	16	52	26	56	53	84	2.81	----	8	----	nw.	----	----	----	19	4	8	----	0.0	0.0
Sandy Hook	22	10	55	29.96	29.99	----	59.2	----	86	2	65	45	31	53	21	53	50	76	9.88	----	10	11,483	w.	52	ne.	18	18	5	8	3.7	0.0	0.0
Trenton	190	159	183	29.79	30.00	----	57.8	----	88	2	67	37	31	49	31	52	49	78	7.41	+4.0	10	7,644	sw.	47	n.	4	16	7	8	4.2	0.0	0.0
Baltimore	123	100	215	29.88	30.00	−.08	61.4	+3.2	88	1	70	43	16	53	26	54	50	74	6.90	+3.9	10	7,293	n.	48	se.	12	18	6	7	3.6	0.0	0.0
Washington	112	62	85	29.88	30.00	−.08	60.4	+3.0	93	1	71	40	16	50	34	53	50	79	5.33	+2.2	8	4,258	s.	30	nw.	3	20	5	6	3.7	0.0	0.0
Cape Henry	18	8	54	29.98	30.00	----	64.4	----	86	1	71	46	19	58	27	59	56	78	4.85	+1.0	7	9,551	ne.	39	nw.	13	18	5	8	3.8	0.0	0.0
Lynchburg	681	153	188	29.29	30.03	−.06	60.4	+1.9	91	1	72	36	16	49	38	53	49	77	6.51	+3.1	8	4,949	nw.	38	nw.	20	18	6	7	3.9	0.0	0.0
Norfolk	91	170	205	29.92	30.02	−.05	64.6	+2.1	88	1	72	44	19	57	25	57	54	77	5.14	+1.2	7	9,337	ne.	48	sw.	3	12	11	8	4.6	0.0	0.0
Richmond	144	11	52	29.87	30.02	−.06	61.4	+1.8	88	1	72	39	22	50	36	55	52	82	2.02	−1.3	7	5,086	ne.	44	w.	3	19	6	6	3.3	0.0	0.0
Wytheville	2,304	49	55	27.68	30.05	−.04	55.6	+2.0	81	1	67	30	15	44	35	49	45	75	1.98	−1.2	6	4,017	w.	28	sw.	12	15	9	7	3.9	0.0	0.0
South Atlantic States							66.5	+2.3										74	3.03	−0.6										3.6		
Asheville	2,253	70	84	27.72	30.06	−.03	58.2	+2.9	81	1	60	34	15	47	37	50	46	72	3.43	+1.0	4	6,018	nw.	34	n.	19	18	8	5	3.1	T.	0.0
Charlotte	779	55	62	29.21	30.04	−.04	64.0	+2.3	90	1	74	40	18	54	34	55	49	68	4.15	+1.0	4	3,016	ne.	17	nw.	19	16	11	4	3.5	0.0	0.0
Hatteras	11	11	50	29.98	29.99	−.07	68.2	+2.3	84	4	73	49	18	63	19	63	60	77	6.85	+0.8	9	11,042	ne.	44	se.	12	16	8	7	4.2	0.0	0.0
Raleigh	376	103	110	29.63	30.03	−.04	63.6	+1.6	85	1	73	43	15	54	20	57	53	77	2.77	−0.7	7	5,745	ne.	42	se.	3	14	8	9	4.6	0.0	0.0
Wilmington	78	81	91	29.94	30.02	−.04	66.4	+1.1	87	4	76	44	19	57	28	60	57	79	1.44	−2.3	8	5,461	ne.	31	sw.	3	17	8	6	3.9	0.0	0.0
Charleston	48	11	92	29.96	30.01	−.05	69.6	+1.8	87	4	77	45	19	62	27	63	60	76	2.37	−1.6	5	8,645	ne.	50	se.	3	18	7	6	3.4	0.0	0.0
Columbia, S. C.	351	41	57	29.65	30.03	−.04	66.8	+2.5	89	4	78	41	19	56	34	57	53	70	4.33	+1.5	4	4,578	ne.	24	w.	12	16	11	4	3.4	0.0	0.0
Due West	711	10	55	29.30	30.07	----	65.0	----	88	1	77	30	19	53	37	----	----	----	3.26	----	6	5,975	ne.	30	w.	12	18	9	4	3.3	0.0	0.0
Greenville, S. C.	1,039	139	146	28.95	30.04	----	65.6	+5.4	86	24	75	39	19	56	31	57	52	69	1.61	----	6	5,869	ne.	43	w.	12	20	5	6	3.2	0.0	0.0
Augusta	182	62	77	29.82	30.01	−.06	68.2	+2.9	92	4	81	42	19	56	40	59	54	71	0.38	−2.0	4	3,961	nw.	22	w.	12	21	7	3	2.9	0.0	0.0
Savannah	65	150	194	29.94	30.01	−.01	69.5	+1.6	90	4	79	42	19	60	33	62	58	77	2.38	−1.2	4	8,861	ne.	35	n.	3	18	8	5	3.2	0.0	0.0
Jacksonville	43	200	245	29.94	29.99	−.03	71.8	+0.7	90	3	80	43	19	64	30	64	60	75	2.20	−2.9	6	8,908	ne.	31	e.	1	9	14	8	5.0	0.0	0.0
Florida Peninsula							77.0	+0.2										79	5.55	−0.2										5.2		
Key West	22	10	64	29.89	29.91	−.03	78.8	−0.3	89	3	84	66	19	74	14	74	72	81	9.16	+3.8	12	7,000	e.	29	nw.	18	11	12	8	5.1	0.0	0.0
Miami	25	71	164	29.91	29.94	----	77.0	0.0	88	3	82	53	19	72	24	71	69	77	3.73	−5.2	15	7,245	e.	28	ne.	16	8	10	13	6.1	0.0	0.0
Tampa	35	79	87	29.92	29.96	−.02	75.3	+1.0	91	11	84	51	19	67	25	68	65	79	3.77	+0.8	7	4,656	ne.	23	se.	6	13	10	8	4.7	0.0	0.0
Titusville	44	5	----	29.91	29.96	----	74.1	----	94	12	83	45	19	65	31	----	----	----	7.71	----	12	----	w.	----	----	----	14	6	11	4.9	0.0	0.0
East Gulf States							69.0	+2.6										68	1.86	−0.9										2.7		
Atlanta	1,173	190	216	28.82	30.05	−.02	68.2	+3.2	88	5	76	39	18	57	29	55	47	57	1.25	−1.1	6	8,290	nw.	39	nw.	18	18	7	6	3.1	0.0	0.0
Macon	370	78	87	29.63	30.03	−.03	67.0	+2.5	90	4	79	42	14	55	40	57	51	67	0.93	−1.2	6	4,713	nw.	25	nw.	18	21	4	6	2.9	0.0	0.0
Thomasville	273	40	58	29.71	30.01	−.03	71.5	+3.3	94	4	83	41	19	60	33	60	55	66	1.24	−2.2	3	3,531	ne.	16	ne.	6	16	8	7	4.0	0.0	0.0
Apalachicola	36	42	49	29.96	30.00	----	71.2	----	87	5	79	46	19	64	24	64	61	76	5.00	----	2	6,331	n.	31	nw.	12	23	4	4	2.7	0.0	0.0
Pensacola	56	149	185	29.95	30.01	−.02	71.0	+1.1	85	4	78	44	19	64	26	64	61	76	2.99	−1.1	4	8,402	n.	35	s.	12	20	7	4	2.8	0.0	0.0
Anniston	741	9	57	29.29	30.08	+.01	64.8	+2.4	92	5	79	35	19	51	45	----	----	----	1.90	−0.4	5	3,285	se.	22	w.	12	20	9	2	2.5	0.0	0.0
Birmingham	700	11	48	29.30	30.06	−.01	68.1	+3.3	94	5	80	38	19	56	38	56	49	62	1.87	−0.5	5	4,339	n.	27	nw.	12	24	4	3	2.1	0.0	0.0
Mobile	57	125	161	29.96	30.02	−.05	70.6	+1.3	90	5	81	44	19	60	29	62	58	73	2.82	−0.4	5	6,341	n.	30	n.	18	17	11	3	3.0	0.0	0.0
Montgomery	223	100	112	29.80	30.05	−.01	69.4	+2.8	94	5	81	41	19	58	37	58	51	60	1.32	−1.1	4	4,158	ne.	26	n.	18	21	5	5	2.7	0.0	0.0
Corinth	469	6	----	----	----	----	65.6	----	91	6	80	38	19	51	42	----	----	----	3.08	----	3	----	se.	----	----	----	17	13	1	----	0.0	0.0
Meridian	375	87	95	29.64	30.04	−.02	67.2	+2.9	92	5	80	40	19	54	38	58	54	72	1.70	−1.0	5	3,026	n.	22	nw.	12	22	5	4	2.5	0.0	0.0
Vicksburg	247	65	73	29.78	30.06	.00	69.5	+2.8	89	5	80	45	18	60	25	60	55	68	2.11	−0.7	6	3,746	n.	31	nw.	12	25	3	3	2.0	0.0	0.0
New Orleans	53	76	84	29.96	30.01	−.02	74.0	+3.0	90	6	82	52	18	66	26	65	62	74	2.23	−0.7	7	4,082	se.	20	nw.	12	21	7	3	2.4	0.0	0.0
West Gulf States							71.2	+3.3										72	3.63	+0.7										2.8		
Shreveport	249	77	93	29.77	30.08	−.02	70.4	+3.8	90	6	81	47	19	60	31	61	57	72	2.66	−0.5	8	3,337	se.	22	nw.	12	22	4	5	2.8	0.0	0.0
Bentonville	1,303	11	44	----	----	----	62.8	+4.8	85	24	76	37	18	49	41	----	----	----	2.80	----	7	3,616	s.	26	s.	11	22	7	2	----	0.0	0.0
Fort Smith	457	79	94	29.54	30.01	−.04	67.0	+4.2	87	25	79	43	13	54	38	57	52	70	2.55	−0.2	5	4,833	e.	40	nw.	11	23	4	4	2.5	0.0	0.0
Little Rock	357	136	144	29.66	30.03	−.03	67.2	+3.6	88	24	78	43	13	56	32	58	53	68	1.37	−1.2	4	5,220	s.	38	s.	2	24	3	4	2.1	0.0	0.0
Austin	605	136	148	29.39	30.02	----	71.5	+3.2	92	3	84	47	13	59	34	----	----	----	6.38	+3.2	4	4,587	se.	38	s.	1	19	8	4	3.4	0.0	0.0
Brownsville	57	53	61	29.90	29.96	----	76.4	+1.5	90	3	85	56	17	68	25	68	65	79	2.56	----	6	4,843	s.	25	n.	12	18	10	3	3.5	0.0	0.0
Corpus Christi	20	11	78	29.98	30.00	.00	75.8	+2.6	92	2	83	50	14	69	24	69	66	79	1.99	−0.1	3	8,121	se.	38	se.	1	22	4	5	2.6	0.0	0.0
Dallas	512	220	227	29.47	30.01	----	70.4	----	88	23	81	52	12	60	32	----	----	----	5.03	----	6	7,749	se.	42	n.	11	23	3	5	2.5	0.0	0.0
Fort Worth	670	106	114	29.30	30.01	−.02	70.6	+3.9	90	21	82	48	13	59	34	60	55	67	4.47	+1.8	4	5,345	s.	29	s.	29	19	5	7	3.4	0.0	0.0
Galveston	54	106	114	29.97	30.03	.00	75.2	+2.5	88	3	81	61	19	69	24	68	65	77	0.50	−3.7	6	6,718	se.	39	n.	12	22	7	2	2.1	0.0	0.0
Groesbeck	461	11	56	29.53	30.01	----	69.8	----	88	20	82	46	13	58	36	----	----	----	9.56	----	7	5,377	se.	37	n.	11	20	7	4	2.9	0.0	0.0
Houston	138	292	314	29.88	30.03	----	74.0	+3.7	90	5	83	53	16	65	28	----	----	----	1.71	−2.0	5	9,088	se.	39	nw.	12	20	8	3	2.9	0.0	0.0
Palestine	510	64	72	29.50	30.03	.00	70.8	+3.6	88	6	82	48	15	60	29	61	56	70	7.77	+4.2	6	4,477	s.	33	s.	2	20	6	5	2.9	0.0	0.0
Port Arthur	34	58	66	29.98	30.02	----	73.7	----	90	3	84	51	13	64	32	----	----	----	0.96	----	5	5,393	s.	34	sw.	2	22	7	2	2.4	0.0	0.0
San Antonio	693	119	132	29.28	30.00	−.01	73.3	+2.8	93	3	85	51	13	62	31	62	56	65	1.44	0.0	5	4,727	se.	32	n.	12	17	9	5	3.2	0.0	0.0
Taylor	583	55	63	29.44	30.05	+0.3	70.7	+2.4	91	7	83	45	13	58	38	----	----	----	9.06	+6.5	7	4,300	s.	33	nw.	11	20	9	2	2.9	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, October, 1927*—Continued

District and station	Elevation of instruments			Pressure			Temperature of the air											Precipitation			Wind										
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Total	Departure from normal	Days with .01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
							60.9	+3.1										69	2.56	0.0										3.6		
Chattanooga	762	189	213	29.24	30.05	-.04	64.9	+3.0	87	5	76	40	18	54	37	54	47	61	1.89	-1.0	5	4,717	nw.	31	nw.	18	20	6	5	3.1	0.0	0.0
Knoxville	995	102	111	29.01	30.07	-.02	63.0	+3.1	90	2	75	40	20	51	36	54	49	70	1.30	-1.3	5	2,977	sw.	25	sw.	12	17	10	4	3.6	0.0	0.0
Memphis	399	76	97	29.62	30.04	-.03	66.4	+3.1	90	1	77	41	18	56	20	56	50	64	2.28	-0.5	4	4,196	sw.	31	nw.	12	21	6	4	2.4	0.0	0.0
Nashville	546	168	191	29.49	30.08	.00	63.6	+2.6	88	1	76	38	19	52	38	54	48	64	3.75	+1.3	4	6,074	nw.	42	s.	12	20	7	4	2.9	0.0	0.0
Lexington	989	193	230	29.00	30.06	-.02	61.1	+3.7	86	1	71	35	19	52	30	......	......	......	1.65	-0.6	6	9,185	sw.	36	s.	11	20	4	7	3.0	0.0	0.0
Louisville	525	188	234	29.48	30.06	-.02	61.8	+2.5	86	1	72	38	18	51	31	53	47	67	3.35	+0.7	5	7,380	n.	36	s.	7	16	12	3	3.3	0.0	0.0
Evansville	431	76	116	29.60	30.07	-.01	62.4	+1.4	87	1	73	37	18	52	30	54	49	68	1.48	-1.6	4	5,898	s.	32	w.	12	17	11	3	3.3	0.0	0.0
Indianapolis	822	194	230	29.15	30.04	-.03	60.0	+4.3	84	6	70	38	18	50	31	51	44	64	2.01	-0.8	5	8,051	s.	38	nw.	12	17	10	4	3.6	0.0	0.0
Royal Center	736	11	55	29.22	30.03	......	56.9	......	82	2	68	32	17	46	34	......	......	......	2.96	......	7	6,851	s.	42	w.	12	13	10	8	4.8	0.0	0.0
Terre Haute	575	96	129	29.41	30.02	......	60.6	......	86	6	72	37	18	50	33	51	46	69	2.50	......	6	6,503	s.	33	s.	2	16	8	7	3.8	0.0	0.0
Cincinnati	627	11	51	29.37	30.05	-.03	59.6	+3.9	88	1	72	32	15	48	42	51	46	70	3.07	+0.8	6	4,871	sw.	29	se.	11	17	8	6	3.3	0.0	0.0
Columbus	822	179	222	29.16	30.04	-.04	59.0	+3.8	88	1	69	37	19	49	35	51	45	69	1.18	-1.2	2	7,227	s.	43	w.	12	19	4	8	3.5	0.0	0.0
Dayton	899	137	173	29.08	30.04	......	59.0	+4.0	85	1	70	36	15	48	37	50	45	69	3.24	+0.8	7	6,461	sw.	36	s.	12	15	9	7	4.2	0.0	0.0
Elkins	1,947	50	67	28.01	30.08	-.02	54.4	+2.1	87	2	67	30	15	42	45	47	44	84	4.56	+2.1	10	3,485	w.	30	s.	12	13	8	10	4.8	T.	0.0
Parkersburg	637	77	82	29.40	30.06	-.02	60.0	+3.9	91	1	72	36	15	48	40	50	46	71	1.99	-0.4	7	3,870	se.	24	nw.	19	19	2	10	4.1	0.0	0.0
Pittsburgh	842	353	410	29.12	30.03	-.05	57.3	+1.6	89	2	67	36	17	48	37	50	46	74	4.09	+1.7	8	7,358	w.	45	se.	12	15	7	9	4.6	0.0	0.0
Lower Lake Region							55.5	+3.4										73	3.01	+0.1										4.9		
Buffalo	767	247	280	29.15	29.98	-.07	54.9	+3.0	92	2	62	37	30	48	33	50	47	78	2.68	-0.7	10	12,310	sw.	58	w.	12	8	15	8	5.6	0.0	0.0
Canton	448	10	61	29.49	29.97	......	49.2	+2.0	81	3	58	21	30	40	37	......	......	......	3.43	+0.1	11	6,924	sw.	41	sw.	12	10	10	11	5.5	0.0	0.0
Oswego	335	76	91	......	29.98	-.07	53.4	+2.2	80	6	61	33	30	46	31	......	......	75	5.50	+2.2	12	7,256	s.	35	sw.	12	10	9	12	......	0.0	0.0
Rochester	523	86	102	29.42	29.99	-.06	55.3	+3.8	87	2	64	36	30	47	33	49	44	72	4.94	+2.1	11	5,637	sw.	28	nw.	21	11	9	11	5.6	0.0	0.0
Syracuse	597	97	113	29.35	29.99	-.07	54.2	+3.2	86	2	62	28	30	46	30	......	......	......	4.70	+1.5	15	5,437	s.	46	s.	12	10	10	11	5.8	0.0	0.0
Erie	714	130	166	29.23	30.00	-.05	57.0	+3.6	87	2	65	40	9	49	30	51	46	72	3.35	-0.4	13	10,886	s.	48	se.	12	12	11	8	4.6	T.	0.0
Cleveland	762	190	201	29.19	30.01	-.05	57.7	+4.1	85	2	66	41	25	50	20	50	45	68	1.85	-0.9	8	10,263	s.	47	n.	19	11	11	9	5.0	0.0	0.0
Sandusky	629	5	67	29.34	30.02	-.04	58.2	+3.9	88	1	68	37	15	48	34	......	......	......	1.11	-1.3	8	6,958	s.	32	w.	1	11	13	7	4.5	0.0	0.0
Toledo	628	208	243	29.34	30.02	-.03	56.7	+3.3	84	2	66	36	17	47	30	49	45	74	0.92	-1.3	7	10,149	sw.	46	sw.	1	18	6	7	3.9	T.	0.0
Fort Wayne	856	113	124	29.00	30.02	......	57.5	+3.8	83	2	68	35	19	47	33	49	45	71	1.86	......	6	6,449	sw.	28	s.	2	19	5	7	3.7	0.0	0.0
Detroit	730	218	258	29.22	30.01	-.04	56.7	+4.2	84	2	65	39	17	48	20	49	45	74	1.65	-0.7	7	7,574	sw.	27	sw.	9	13	8	10	4.7	0.0	0.0
Upper Lake Region							51.6	+3.1										79	2.17	+0.6										5.4		
Alpena	609	13	92	29.31	29.98	-.05	49.7	+2.6	80	27	58	30	10	41	36	45	42	82	1.81	-1.6	11	8,553	nw.	39	nw.	20	8	12	11	5.9	0.0	0.0
Escanaba	612	54	60	29.29	29.96	-.05	48.8	+2.8	70	20	56	30	18	41	29	44	40	79	2.51	-0.6	9	7,595	s.	31	nw.	20	12	10	9	4.9	0.0	0.0
Grand Haven	632	54	89	29.29	29.98	-.05	54.0	+3.3	81	2	62	32	18	46	29	50	46	80	3.46	+1.0	10	8,461	s.	37	w.	12	11	10	10	4.8	0.0	0.0
Grand Rapids	707	70	87	29.22	30.00	-.04	55.5	+4.3	84	2	64	33	18	46	27	49	45	75	3.03	+0.5	10	3,983	s.	19	nw.	21	9	10	12	5.8	0.0	0.0
Houghton	668	64	99	29.19	29.92	-.08	47.6	+1.9	69	2	55	32	17	40	30	......	......	......	2.74	-0.4	11	7,015	e.	35	w.	31	6	10	15	6.4	T.	0.0
Lansing	878	11	62	29.05	30.00	......	54.0	+3.7	84	2	65	32	19	43	32	48	46	85	1.88	-0.4	10	3,834	s.	19	s.	15	18	9	4	3.8	T.	0.0
Ludington	637	60	66	29.27	29.97	......	52.7	......	78	2	59	35	17	46	26	48	46	81	2.53	......	12	8,267	s.	39	s.	15	13	9	9	4.6	0.0	0.0
Marquette	734	77	111	29.15	29.96	-.05	49.2	+2.5	76	27	56	34	14	42	31	44	40	79	1.67	-1.5	10	7,146	w.	34	s.	2	4	7	20	7.4	0.0	0.0
Port Huron	638	70	120	29.29	29.99	-.05	54.2	+3.7	83	2	63	34	10	45	30	48	45	77	0.68	-2.0	7	8,584	sw.	34	s.	12	8	17	6	4.9	0.0	0.0
Sault Sainte Marie	614	11	52	29.27	29.98	-.03	47.7	+3.1	68	5	55	32	18	40	26	44	41	84	2.42	-0.8	15	6,246	nw.	34	nw.	20	4	9	18	7.2	0.0	0.0
Chicago	673	7	131	29.28	30.00	-.04	58.0	+4.0	83	27	66	40	19	50	28	50	46	72	1.77	-0.8	8	8,048	sw.	36	sw.	2	16	4	11	4.5	0.0	0.0
Green Bay	617	100	141	29.29	29.96	-.06	50.8	+2.3	76	27	60	33	14	42	35	45	42	78	1.07	-0.4	9	7,642	s.	33	n.	6	7	12	12	6.0	0.0	0.0
Milwaukee	681	125	221	29.24	29.98	-.05	54.9	+3.8	81	27	63	38	14	47	27	49	45	76	3.37	+1.0	8	9,599	w.	48	s.	2	16	4	11	4.3	0.0	0.0
Duluth	1,133	5	47	28.71	29.94	-.06	46.0	+1.9	74	19	54	28	9	38	31	41	37	82	0.91	-1.8	6	9,589	ne.	46	nw.	13	9	11	11	5.7	T.	0.0
North Dakota							47.8	+4.2										72	1.42	+0.1										5.2		
Moorhead	940	50	58	28.90	29.93	-.07	47.8	+3.3	81	19	59	23	9	37	44	41	37	75	1.37	-0.7	6	5,900	s.	34	nw.	10	11	5	15	6.0	0.7	0.0
Bismarck	1,674	8	57	28.15	29.94	-.05	49.4	+4.5	88	19	62	28	8	36	50	41	34	67	0.53	-0.5	4	6,637	nw.	38	nw.	14	12	16	3	4.2	0.0	0.0
Devils Lake	1,478	11	44	28.33	29.93	-.06	45.8	+5.3	81	19	57	26	9	34	38	39	34	76	2.27	+1.0	8	6,614	nw.	30	w.	10	11	7	13	5.4	0.0	0.0
Ellendale	1,457	10	56	28.36	29.94	......	48.3	......	83	21	62	21	9	34	51	......	......	......	0.93	......	7	8,993	nw.	50	nw.	10	8	9	14	6.0	0.0	0.0
Grand Forks	833	12	67	......	......	......	46.4	......	80	19	57	28	8	36	40	41	......	......	1.64	......	9	......	nw.	31	se.	24	11	9	11	5.0	1.4	0.0
Williston	1,878	41	48	27.94	29.94	-.04	46.9	+3.5	81	19	58	26	13	36	40	40	34	70	1.49	+0.7	8	4,942	w.	40	nw.	14	11	10	10	4.9	0.8	0.0
Upper Mississippi Valley							56.8	+3.7										74	3.36	+0.9										4.0		
Minneapolis	918	102	208	28.94	29.93	......	51.8	+2.9	80	26	62	30	9	42	33	......	......	......	2.30	-0.3	9	8,079	s.	31	nw.	12	14	5	12	5.1	0.0	0.0
St. Paul	837	236	261	29.04	29.95	-.06	51.0	+2.4	79	26	61	30	14	41	33	......	......	......	2.25	-0.1	9	8,605	sw.	39	s.	30	13	6	12	5.2	0.0	0.0
La Crosse	714	11	48	29.19	29.96	-.06	52.8	+2.5	85	26	64	29	14	42	37	45	42	80	2.78	+0.3	11	2,950	s.	20	s.	30	15	6	10	4.5	0.0	0.0
Madison	974	70	78	28.94	29.90	-.04	53.6	+3.3	80	26	62	35	14	45	32	48	44	78	4.23	+1.8	10	6,126	sw.	26	s.	2	18	4	9	4.2	0.0	0.0
Wausau	1,247	4	......	28.63	29.97	......	49.5	......	80	27	60	27	18	39	37	......	......	......	2.67	......	11	......	n.	......	......	......	17	4	10	4.3	0.3	0.0
Charles City	1,015	10	49	28.90	29.98	-.04	52.4	+3.8	84	26	64	28	14	40	37	45	42	80	1.33	-0.7	8	4,344	se.	27	sw.	30	17	5	9	3.8	0.0	0.0
Davenport	606	71	79	29.33	29.99	-.05	57.8	+4.1	84	27	68	35	14	47	32	50	46	74	5.25	+2.9	8	4,242	s.	28	s.	5	17	2	12	4.2	0.0	0.0
Des Moines	861	84	97	29.06	29.97	-.06	57.6	+4.2	87	25	70	32	14	46	38	49	44	69	2.16	-0.5	5	4,647	sw.	34	sw.	30	16	6	9	4.2	0.0	0.0
Dubuque	700	81	96	29.23	29.98	-.06	55.0	+3.1	83	27	65	31	14	45	36	48	44	77	4.55	+1.9	10	3,797	s.	20	n.	6	16	5	10	4.2	T.	0.0
Keokuk	614	64	78	29.34	30.01	-.04	59.3	+3.9	85	27	70	35	14	49	36	51	46	70	4.16	+1.7	6	4,783	s.	35	s.	2	15	8	8	4.0	0.0	0.0
Cairo	358	87	93	29.67	30.05	-.02	63.5	+3.1	86	28	74	40	18	53	30	55	50	72	2.18	-0.4	4	5,206	n.	33	se.	11	17	7	7	3.0	0.0	0.0
Peoria	609	11	45	29.36	30.03	-.02	58.0	+6.0	86	27	70	32	14	46	38	50	47	79	4.20	+1.6	7	3,878	s.	26	sw.	2	20	3	8	3.0	0.0	0.0
Springfield, Ill	636	10	91	29.34	30.02	-.03	59.8	+4.0	84	27	70	37	14	50	30	52	47	73	2.10	-0.4	5	5,515	s.	31	s.	2	18	5	8	3.8	0.0	0.0
Hannibal	534	74	109	29.44	30.02	-.03	59.8	+3.8	86	27	71	32	14	48	35	......	......	......	4.82	+2.2	6	5,902	sw.	30	s.	30	17	5	9	4.0	0.0	0.0
St. Louis	568	265	303	29.42	30.03	-.03	62.8	+4.5	86	6	73	40	18	53	31	53	47	66	4.05	+2.2	6	6,792	sw.	54	sw.	2	20	6	5	2.9	0.0	0.0
Missouri Valley							58.3	+4.6										63	2.36	+0.5										3.1		
Columbia, Mo	784	11	84	29.18	30.02	-.03	60.6	+4.0	87	27	72	35	18	49	36	......	......	......	5.08	+2.7	4	5,252	se.	31	se.	2	21	3	7	2.7	0.0	0.0
Kansas City	963	161	181	28.97	30.00	-.04	62.7	+5.0	86	27	73	41	13	52	29	52	45	60	5.30	+3.1	7	7,361	s	36	n.	11	23	4	4	2.4	0.0	0.0
St. Joseph	967	11	49	28.95	29.98	......	61.2	......	88	27	73	39	13	49	37	51	45	65	4.63	......	7	5,461	se.	34	nw.	12	23	5	3	2.5	0.0	0.0
Springfield, Mo	1,324	98	104	28.60	30.00	-.05	62.2	+4.0	84	25	73	39	18	51	33	52	46	63	4.29	+1.5	6	6,939	s.	28	s.	2	25	2	4	2.1	0.0	0.0
Iola	984	11	50	28.96	30.00	-.04	61.9	+4.1	89	24	76	35	13	48	44	......	......	......	4.14	+1.4	6	4,160	s.	24	s.	29	22	6	3	2.4	0.0	0.0
Topeka	987	92	107	......	......	......	61.9	+4.9	88	22	74	38	13	49	35	......	......	......	3.05	+1.1	6	6,534	sw.	34	nw.	6	24	3	4	2.1	0.0	0.0
Lincoln	1,189	11	84	28.71	29.97	-.06	58.6	+4.4	89	24	72	31	31	46	41	48	42	62	0.50	-1.3	5	6,947	s.	36	sw.	29	17	7	7	3.7	0.0	0.0
Omaha	1,105	115	122	28.79	29.97	-.06	59.1	+4.8	87	22	70	36	13	48	32	49	43	62	1.12	-1.2	7	5,088	s.	34	nw.	12	19	7	5	3.4	0.0	0.0
Valentine	2,598	47	54	27.27	29.98	-.03	54.0	+4.7	88	18	70	26	13	38	48	42	33	59	1.73	+0.4	8	6,124	w.	31	nw.	10	20	4	7	3.3	0.0	0.0
Sioux City	1,135	94	164	28.76	29.98	-.04	55.8	+4.9	84	25	68	32	7	44	41	47	41	66	0.88	-0.9	6	8,263	s.	43	s.	4	16	9	6	3.8	0.0	0.0
Huron	1,306	59	74	28.56	29.97	-.04	52.4	+4.7	88	21	67	26	9	38	50	43	36	65	0.49	-0.8	8	6,492	nw.	45	s.	29	13	12	6	4.4	0.0	0.0
Pierre	1,572	70	75	......	29.97	-.04	54.3	+4.5	90	21	68	28	9	40	50	......	......	62	1.19	+0.4	7	5,602	nw.	40	nw.	10	16	9	6	......	0.0	0.0
Yankton	1,233	49	57	28.64	29.96	-.05	56.0	+4.9	87	25	69	33	13	43	44	......	......	......	0.54	-1.0	3	5,002	nw.	34	sw.	4	14	11	6	4.4	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, October, 1927*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope							49.2	+4.0										59	1.13	+0.2										4.6		
Billings	3,140	5					50.2		89	16	68	21	30	32	57				0.15		5		nw.				14	6	11			
Havre	2,505	11	44	27.29	29.94	−.04	49.1	+4.6	85	17	62	23	31	37	48	41	35	66	1.03	+0.5	8	5,219	sw.	35	sw.	10	6	15	10	5.7	1.0	0.0
Helena	4,110	87	112	25.79	29.99	−.04	49.0	+4.1	80	16	59	26	31	39	38	40	31	56	0.81	0.0	7	5,828	sw.	34	sw.	12	5	10	16	6.3	0.1	0.0
Kalispell	2,973	48	56	26.92	29.90	−.02	45.8	+2.3	72	21	54	25	31	38	35	41	37	76	3.17	+2.0	13	3,062	nw.	30	sw.	9	7	8	16	6.9	1.2	T.
Miles City	2,371	48	55	27.44	30.01	+.01	50.9	+4.4	86	17	66	24	31	36	47	41	34	61	0.33	−0.4	5	3,958	s.	32	e.	4	18	7	6	3.6	0.0	0.0
Rapid City	3,259	50	58	26.60	30.02	+.01	52.6	+4.1	88	17	65	29	13	40	45	41	32	54	0.83	−0.3	6	5,209	w.	33	nw.	11	14	10	7	4.3	T.	0.0
Cheyenne	6,088	84	101	24.04	30.01	.00	48.9	+4.1	74	18	62	25	6	36	40	37	26	48	1.77	+1.0	7	8,127	w.	47	w.	10	18	7	6	3.5	1.3	T.
Lander	5,372	60	68	24.68	30.04	.00	47.6	+4.1	74	21	62	23	31	33	42	37	28	52	0.48	−0.6	4	3,208	sw.	36	nw.	10	16	11	4	3.6	1.4	0.0
Sheridan	3,790	10	47	26.09	30.00		48.4		85	17	65	23	6	32	55	38	30	62	0.11		2	3,305	nw.	35	nw.	11	12	13	6	4.5	T.	0.0
Yellowstone Park	6,241	11	48	23.92	30.06	+.04	43.2	+1.7	72	16	54	12	31	32	38	34	27	60	1.53	+0.4	9	5,404	s.	27	s.	17	12	10	9	5.0	6.1	1.5
North Platte	2,821	11	51	27.07	29.99	−.03	56.1	+6.4	89	18	73	30	13	39	49	43	35	59	0.26	−0.9	4	4,771	w.	31	nw.	11	21	5	5	2.6	0.0	0.0
Middle Slope							60.0	+4.2										54	2.01	+0.5										2.1		
Denver	5,292	106	113	24.77	30.01	.00	54.6	+3.4	79	19	68	30	12	41	42	41	29	45	0.19	−0.8	4	5,087	s.	30	nw.	11	22	5	4	2.6	T.	0.0
Pueblo	4,685	80	86	25.32	29.99	.00	55.2	+3.2	82	26	72	29	12	38	46	41	26	41	0.01	−0.7	1	3,887	nw.	39	w.	2	21	8	2	2.6	0.0	0.0
Concordia	1,392	50	58	28.51	29.99	−.04	60.2	+4.3	87	24	73	36	13	47	38	48	41	60	0.87	−1.1	4	5,582	s.	29	nw.	12	22	5	4	2.8	0.0	0.0
Dodge City	2,509	11	51	27.42	30.02	.00	60.6	+4.5	88	20	76	36	12	45	46	40	37	55	0.23	−1.2	5	5,995	sw.	31	s.	4	26	4	1	1.3	0.0	0.0
Wichita	1,358	139	158	28.56	29.98	−.05	63.5	+4.9	87	23	75	39	13	52	33	53	46	61	2.96	+0.7	6	9,746	s.	46	s.	10	25	2	4	1.8	0.0	0.0
Broken Arrow	765	11	56	29.19	30.02		66.0		88	23	79	42	13	53	36				3.26		6	8,527	s.	50	nw.	11	22	6	3	2.3	0.0	0.0
Oklahoma City	1,214	10	47	28.74	30.01	−.02	66.2	+4.7	90	19	79	45	12	54	37	55	49	66	7.81	+6.0	5	7,021	s.	34	n.	11	26	3	2	1.6	0.0	0.0
Southern Slope							66.0	+2.9										54	0.90	−0.9										2.2		
Abilene	1,738	10	52	28.22	30.02	+.01	67.3	+1.9	90	11	81	44	17	54	39	55	49	64	0.71	−1.6	5	5,706	s.	35	ne.	11	22	4	5	2.7	0.0	0.0
Amarillo	3,676	10	49	26.30	30.00	.00	63.3	+5.6	90	5	78	37	12	49	40	48	37	48	0.14	−1.6	2	6,041	sw.	26	s.	4	27	3	1	1.5	0.0	0.0
Del Rio	944	64	71	28.98	29.96	−.02	72.1	+2.1	92	3	83	50	17	61	33	61	55	63	2.40	+0.4	4	5,189	se.	30	ne.	12	22	6	3	2.7	0.0	0.0
Roswell	3,566	75	85	26.39	29.98	+.02	61.4	+1.9	91	4	78	34	31	44	45	46	30	40	0.33	−0.9	1	4,890	s.	38	nw.	28	26	4	1	1.8	0.0	0.0
Southern Plateau							61.6	+1.6										46	0.44	−0.1										1.8		
El Paso	3,778	152	175	26.21	29.95	+.03	66.0	+2.5	80	4	79	41	31	53	35	49	34	36	0.02	−0.9	1	7,003	e.	39	w.	28	23	7	1	1.9	0.0	0.0
Santa Fe	7,013	38	53	23.32	30.00	+.04	51.3	+0.9	71	20	65	27	12	38	35	38	27	46	0.29	−0.8	2	4,024	e.	33	sw.	28	22	6	3	2.1	0.0	0.0
Falgstaff	6,907	10	50	23.41	29.99	+.07	47.4	+2.7	73	23	64	23	1	31	43	36		60	1.05		5	5,235	n.	29	s.	28	24	6	1		T.	0.0
Phoenix	1,108	10	82	28.74	29.89	+.01	71.5	+0.9	98	15	88	49	2	55	43	54	40	40	0.57	+0.2	3	3,134	e.	26	w.	28	24	4	3	2.0	0.0	0.0
Yuma	141	9	54	29.73	29.87	.00	74.4	+1.1	100	15	90	52	29	59	42	58	47	48	1.06	+0.9	3	2,805	ne.	25	nw.	27	27	3	1	1.1	0.0	0.0
Independence	3,957	5	25	25.98	29.99	+.04	59.3	+1.8	86	19	77	30	9	41	48	45			0.26	−0.1	3		nw.				25	1	5		0.0	0.0
Middle Plateau							52.9	+2.6										43	1.12	+0.3										2.9		
Reno	4,532	74	81	25.50	30.00	+.01	53.4	+3.7	83	15	70	24	7	37	47	41	29	45	1.25	+0.9	6	3,924	w.	30	sw.	16	21	5	5	2.8	0.0	0.0
Tonopah	6,090	12	20				54.5		74	15	64	30	6	46	24	40	23	33	0.90		4		se.									
Winnemucca	4,344	18	56	25.68	30.08	+.03	49.8	+1.5	84	16	69	18	9	31	55	38	27	50	0.91	+0.4	4	4,898	ne.	29	sw.	26	17	12	2	3.4	0.0	0.0
Modena	5,473	10	43	24.66	29.99	+.03	50.9	+2.9	78	15	67	22	8	34	48	38	22	41	1.64	+0.8	4	6,309	w.	39	nw.	27	23	4	4	2.4	1.4	1.4
Salt Lake City	4,360	163	203	25.67	30.04	+.03	55.4	+2.9	82	16	66	32	31	45	31	43	22	45	1.19	−0.2	6	4,983	nw.	32	s.	24	21	1	9	3.2	0.0	0.0
Grand Junction	4,602	60	68	25.43	30.01	+.02	54.8	+2.0	79	15	69	34	8	41	39	41	28	44	0.60	−0.3	3	3,737	se.	24	w.	2	20	7	4	2.5	0.0	0.0
Northern Plateau							52.6	+2.7										61	1.16	0.0										5.0		
Baker	3,471	48	53	26.48	30.08	.00	48.6	+2.0	78	20	61	19	31	36	38	41	33	63	0.61	−0.3	9	3,041	se.	27	sw.	3	10	12	9	5.3	T.	0.0
Boise	2,739	78	86	27.21	30.08	+.02	54.1	+3.0	87	16	66	29	31	42	40	44	35	56	1.09	−0.2	7	2,621	se.	23	nw.	3	17	8	6	3.9	0.0	0.0
Lewiston	757	40	48	29.22	30.04	+.03	54.4	+2.9	80	16	66	30	31	43	38				1.75	+0.6	13	1,559	e.	17	w.	30	10	11	10	5.3	0.0	0.0
Pocatello	4,477	60	68	25.52	30.04	+.03	52.6	+4.2	80	19	65	26	7	41	40	40	28	47	1.09	+0.1	6	6,429	se.	32	sw.	10	17	7	7	3.9	T.	0.0
Spokane	1,929	101	110	27.96	30.02	−.04	50.3	+2.0	76	16	59	29	31	41	33	45	40	70	1.55	+0.4	9	4,341	s.	25	sw.	9	5	13	13	6.5	0.0	0.0
Walla Walla	991	57	65	28.95	30.02	−.05	55.5	+2.0	78	18	64	36	31	47	27	40	44	68	1.01	−0.5	7	3,101	s.	25	w.	3	10	10	11	5.3	0.0	0.0
North Pacific Coast Region							53.8	+1.7										80	4.74	+1.6										7.0		
North Head	211	11	56	29.76	29.98	−.07	54.2	+1.3	72	19	58	43	31	50	17	52	50	86	5.61	+1.5	24	12,096	s.	78	s.	16	2	7	22	8.3	0.0	0.0
Port Angeles	29	8	53	29.97	30.00		49.6		64	15	56	37	6	44	20				3.69	+1.1	18	4,093	sw.	30	w.	9	1	12	18	7.8	0.0	0.0
Seattle	125	215	250	29.87	30.00	−.05	53.2	+1.8	70	12	59	39	31	47	21	50	47	82	3.85	+1.2	16	6,346	s.	43	sw.	16	3	10	18	7.4	0.0	0.0
Tacoma	194	172	201	29.80	30.01	−.03	53.4	+2.9	71	12	60	34	31	47	25				3.47	+0.3	17	5,877	s.	40	s.	16	3	12	16	7.6	0.0	0.0
Tatoosh Island	86	9	53	29.87	29.97	−.04	51.8	+1.9	60	19	55	43	3	49	9	50	48	88	12.53	+4.5	23	12,606	e.	62	s.	16	3	8	20	7.9	0.0	0.0
Yakima	1,071	5					50.8		80	19	66	19	31	36	47				0.90		3		nw.				5	17	9	5.6	0.0	0.0
Medford	1,425	4		[1]28.51	[1]30.02		53.5		81	15	68	30	6	39	44	47	41	69	0.91		10		n.				8	16	7	5.1	0.0	0.0
Portland, Oreg.	153	68	106	29.88	30.04	−.02	55.0	+0.8	75	15	62	34	31	47	24	51	47	79	2.65	−0.6	16	3,469	se.	37	w.	3	1	13	17	7.6	0.0	0.0
Roseburg	510	75	99	29.50	30.06	−.02	55.4	+1.5	83	15	66	32	31	44	38	50	46	75	1.37	−1.2	10	2,165	nw.	29	w.	16	11	9	11	5.6	0.0	0.0
Middle Pacific Coast Region							61.7	+1.4										65	1.39	−0.1										3.3		
Eureka	62	73	89	30.00	30.07	+.01	53.8	+0.2	69	17	60	40	31	47	22	51	49	88	1.17	−1.5	9	3,730	n.	28	n.	10	9	8	14	5.8	0.0	0.0
Red Bluff	332	50	56	29.61	29.97	−.06	65.2	+0.9	92	12	78	45	28	52	39	53	41	48	1.58	0.0	5	4,450	nw.	30	nw.	31	23	5	3	2.6	0.0	0.0
Sacramento	69	106	117	29.88	29.95	−.04	65.4	+2.5	90	13	78	46	6	52	36	54	43	51	1.45	+0.4	4	4,403	nw.	31	nw.	31	24	4	3	2.0	0.0	0.0
San Francisco	155	208	243	29.80	29.97	−.04	62.5	+2.0	86	12	71	48	14	54	30	54	50	74	1.93	+0.6	4	4,418	w.	34	ne.	31	18	9	4	3.2	0.0	0.0
San Jose	141	12	110	29.83	29.98		61.8	+1.5	89	12	76	38	6	48	44				0.83	+0.1	3	3,946	nw.	29	sw.	25	19	8	4	3.1	0.0	0.0
South Pacific Coast Region							66.3	+2.0										65	2.05	+1.4										3.1		
Fresno	327	80	98	29.60	29.95	−.01	67.0	+3.0	94	20	81	46	6	53	38	54	42	48	2.35	+1.6	5	3,528	nw.	26	nw.	16	25	2	4	2.1	0.0	0.0
Los Angeles	338	159	191	29.58	29.94	−.01	67.4	+2.1	96	20	77	54	13	58	32	57	50	65	2.04	+1.3	2	3,669	sw.	24	ne.	31	17	9	5	3.3	0.0	0.0
San Diego	87	62	70	29.84	29.93	−.02	64.6	+0.9	94	20	72	54	2	58	31	59	57	82	1.76	+1.3	4	3,765	nw.	30	s.	31	15	11	5	4.0	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54																													
Panama Canal																																
Balboa Heights	118	7	97	29.73	29.85	0.0	79.2	0.0	90	4	84	72	30	74	15	75	74		8.36	−2.0	23	5,372	s.	32	s.	18	0	18	13	7.1	0.0	0.0
Colon	38	7	97	29.81	29.84	0.0	81.4	+1.6	94	10	88	72	30	75	19	76	75		13.12	−2.4	25	4,880	s.	26	n.	1	0	6	25	8.7	0.0	0.0
Alaska																																
Juneau	80	11	54	[1]29.60	[1]29.69		41.9		52	3	46	31	31	38	16	40	36	80	13.64		20	6,791	se.	40	se.	14	3	1	27	8.8	0.4	0.0
Hawaiian Islands																																
Honolulu	39	86	100	[1]29.99	[1]30.03		77.7		85	2	82	70	18	73	12	70	66	68	0.70	−0.8	12	6,432	e.	28	e.	24	8	21	2	4.7	0.0	0.0

[1] Pressure not corrected to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, October, 1927*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*In.*	*In.*	*In.*
Cape Race, N. F.	99												
Sydney, C. B. I.	48												
Halifax, N. S.	88												
Yarmouth, N. S.	65												
Charlottetown, P. E. I.	38												
Chatham, N. B.	28												
Father Point, Que.	20	29.87	29.89	−.06	43.0	+3.2	48.4	37.6	70	26	4.96	+2.06	0.0
Quebec, Que.	296	29.62	29.94	−.06	47.3	+4.9	52.7	42.0	69	30	4.58	+1.43	0.1
Doucet, Que.	1,236												
Montreal, Que.	187	29.73	29.94	−.07	49.8	+5.0	56.1	43.6	80	33	3.70	+0.57	0.0
Ottawa, Ont.	236	29.70	29.96	−.05	50.4	+6.6	59.9	40.8	81	26	1.92	−0.63	T.
Kingston, Ont.	285	29.65	29.96	−.07	52.5	+5.5	59.3	45.7	76	32	3.34	+0.61	0.0
Toronto, Ont.	379	29.57	29.96	−.06	53.0	+6.4	61.1	44.8	77	35	2.19	−0.17	0.0
Cochrane, Ont.	930												
White River, Ont.	1,244	28.59	29.92	−.06	39.4	+2.3	49.1	29.8	65	16	4.87	+2.52	0.0
London, Ont.	808				53.0		63.9	42.2	83	30	2.93		0.0
Southampton, Ont.	656	29.26	29.96	−.04	51.4	+5.3	60.0	42.8	86	30	2.14	−1.08	T.
Parry Sound, Ont.	688	29.26	29.96	−.05	46.8	+2.9	52.2	41.5	71	28	3.68	−0.24	T.
Port Arthur, Ont.	644	29.24	29.95	−.03	45.0	+5.1	52.5	37.5	69	26	1.67	−0.89	0.0
Winnipeg, Man.	760	29.08	29.91	−.07	45.9	+6.8	54.6	37.2	76	29	3.17	+1.47	T.
Minnedosa, Man.	1,690	28.09	29.92	−.05	43.6	+5.8	53.1	34.1	73	24	1.28	+0.08	T.
Le Pas, Man.	860				41.4		51.1	31.7	69	18	1.01		2.9
Qu'Appelle, Sask.	2,115	27.62	29.87	−.10	43.5	+4.1	52.4	34.6	77	24	1.72	+0.62	1.4
Moose Jaw, Sask.	1,759				45.4		56.6	34.2	85	22	1.08		2.1
Swift Current, Sask.	2,392	27.31	29.83	−.14	45.9	+3.8	57.4	34.4	81	23	1.29	+0.41	0.1
Medicine Hat, Alb.	2,144												
Calgary, Alb.	3,428												
Banff, Alb.	4,521												
Prince Albert, Sask.	1,450	28.33	29.90	−.07	43.1	+6.0	52.8	33.4	82	22	0.82	−0.01	0.4
Battleford, Sask.	1,592	28.12	29.86	−.11	43.3	+3.7	54.3	32.4	80	21	0.80	+0.44	0.3
Edmonton, Alb.	2,150												
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.74	29.99	−.02	50.8	+1.6	55.5	46.2	64	28	4.74	+2.37	0.0
Barkerville, B. C.	4,180												
Estevan Point, B. C.	20												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	29.89	30.05	+.03	75.5	+2.5	82.5	68.5	88	63	5.08	−1.63	0.0

LATE REPORTS, SEPTEMBER, 1927

Sydney, C. B. I.	48	29.87	29.92	−.09	58.0	+1.5	66.0	50.1	76	36	4.10	+0.82	0.0
Halifax, N. S.	88	29.71	29.81	−.23	57.5	−0.1	65.0	50.0	73	40	3.07	−0.64	0.0
Yarmouth, N. S.	65	29.85	29.92	−.13	55.8	−0.3	63.4	48.2	76	35	3.05	−0.56	0.0
Charlottetown, P. E. I.	38	29.83	29.87	−.14	58.3	+1.0	64.6	52.0	75	40	2.21	−1.19	0.0
Chatham, N. B.	28	29.82	29.85	−.15	54.5	−0.9	63.9	45.2	74	26	2.81	+0.10	0.0
Winnipeg, Man.	760	29.09	29.91	−.03	57.3	+4.8	67.4	47.2	89	28	2.54	+0.51	T.
Edmonton, Alb.	2,150	27.57	29.84	−.06	48.9	−0.4	59.8	38.0	79	25	2.14	+0.81	3.1
Barkerville, B. C.	4,180	25.62	29.90	−.08	45.2	−1.5	54.7	35.7	67	22	3.77	+0.86	0.0
Estevan Point, B. C.	20				54.5		60.2	48.9	74	40	5.96		0.0

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Chart I. Tracks of Centers of Anticyclones, October, 1927. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Wilfred P. Day)

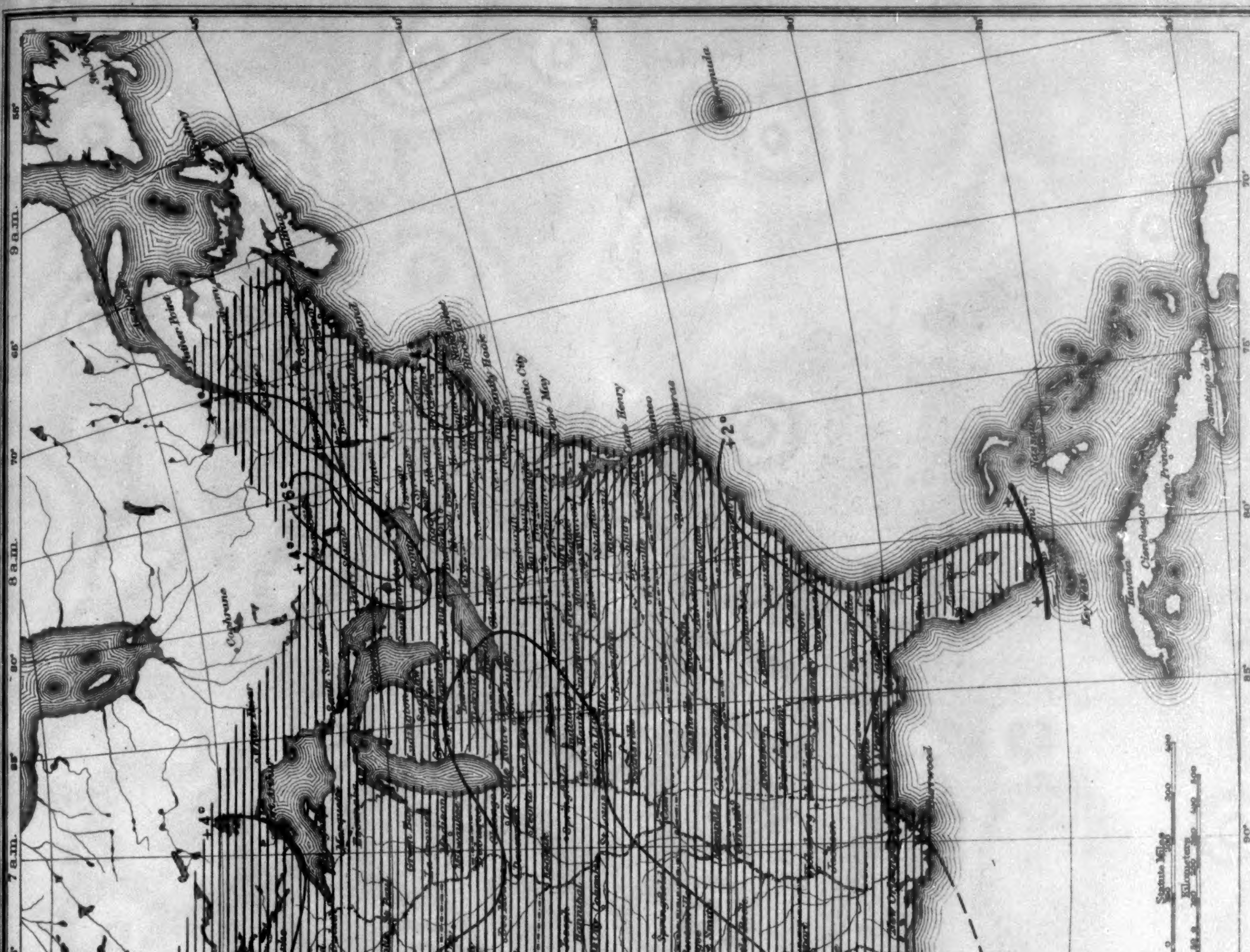
Chart I. Tracks of Centers of Anticyclones, October, 1927. (Inset) Departure of Monthly Mean Pressure from Normal
(Plotted by Wilfred P. Day)

Chart II. Tracks of Centers of Cyclones, October, 1927. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)

Chart III. Departure (°F.) of the Mean Temperature from the Normal, October, 1927

Chart III. Departure (°F.) of the Mean Temperature from the Normal, October, 1927



Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.

Chart IV. Total Precipitation, Inches, October, 1927. (Inset) Departure of Precipitation from Normal

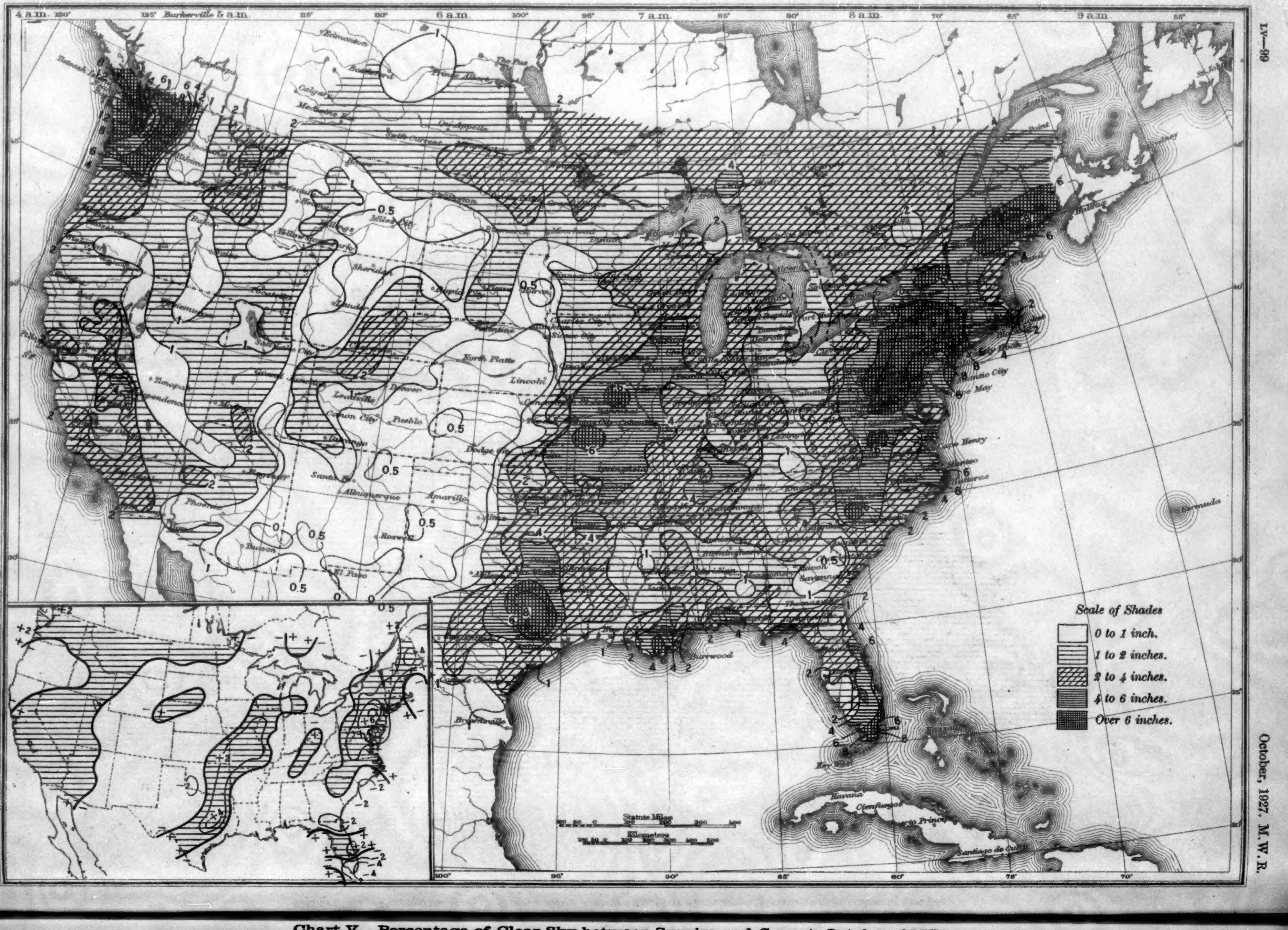


Chart V. Percentage of Clear Sky between Sunrise and Sunset, October, 1927

Chart V. Percentage of Clear Sky between Sunrise and Sunset, October, 1927

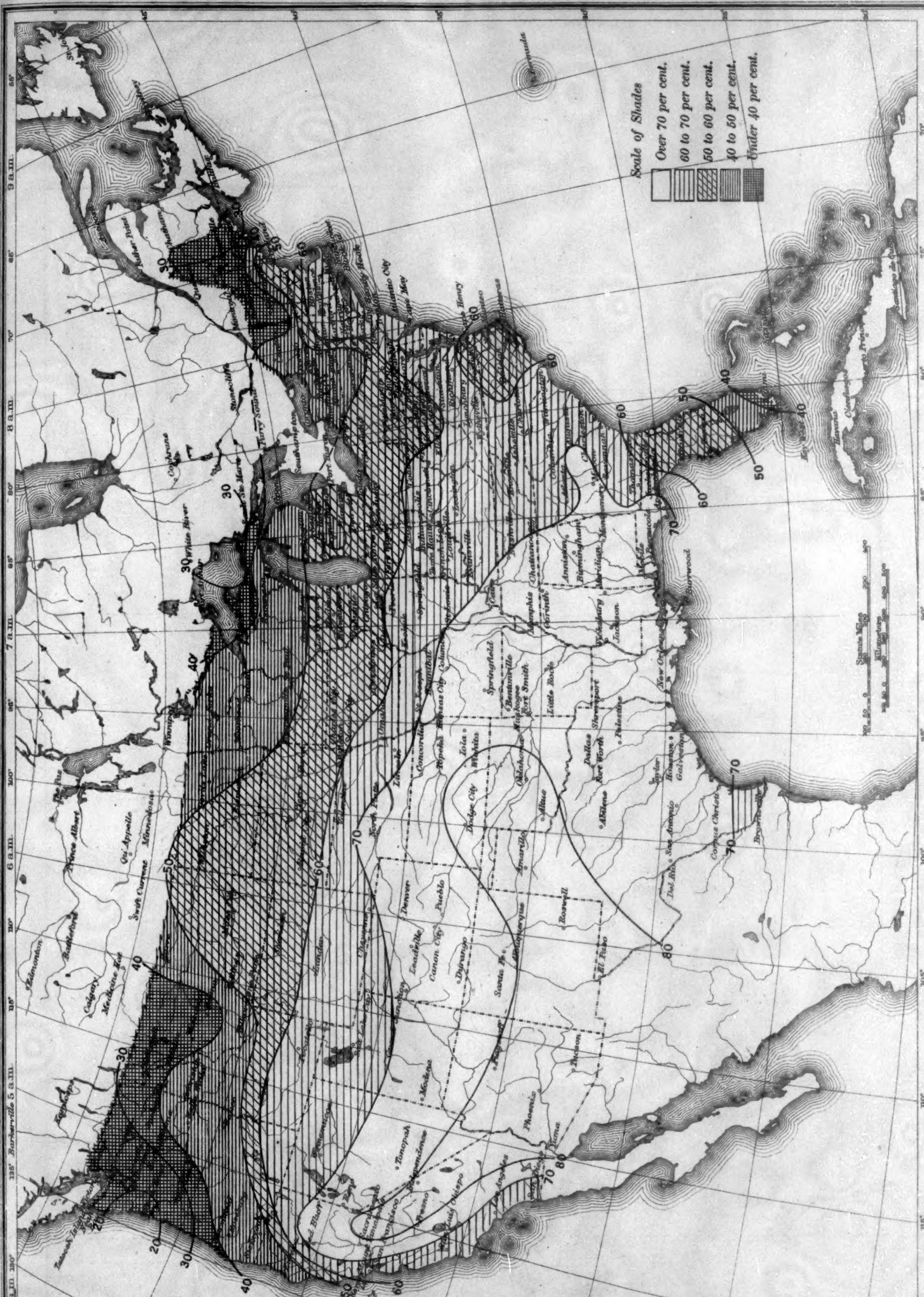


Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, October, 1927

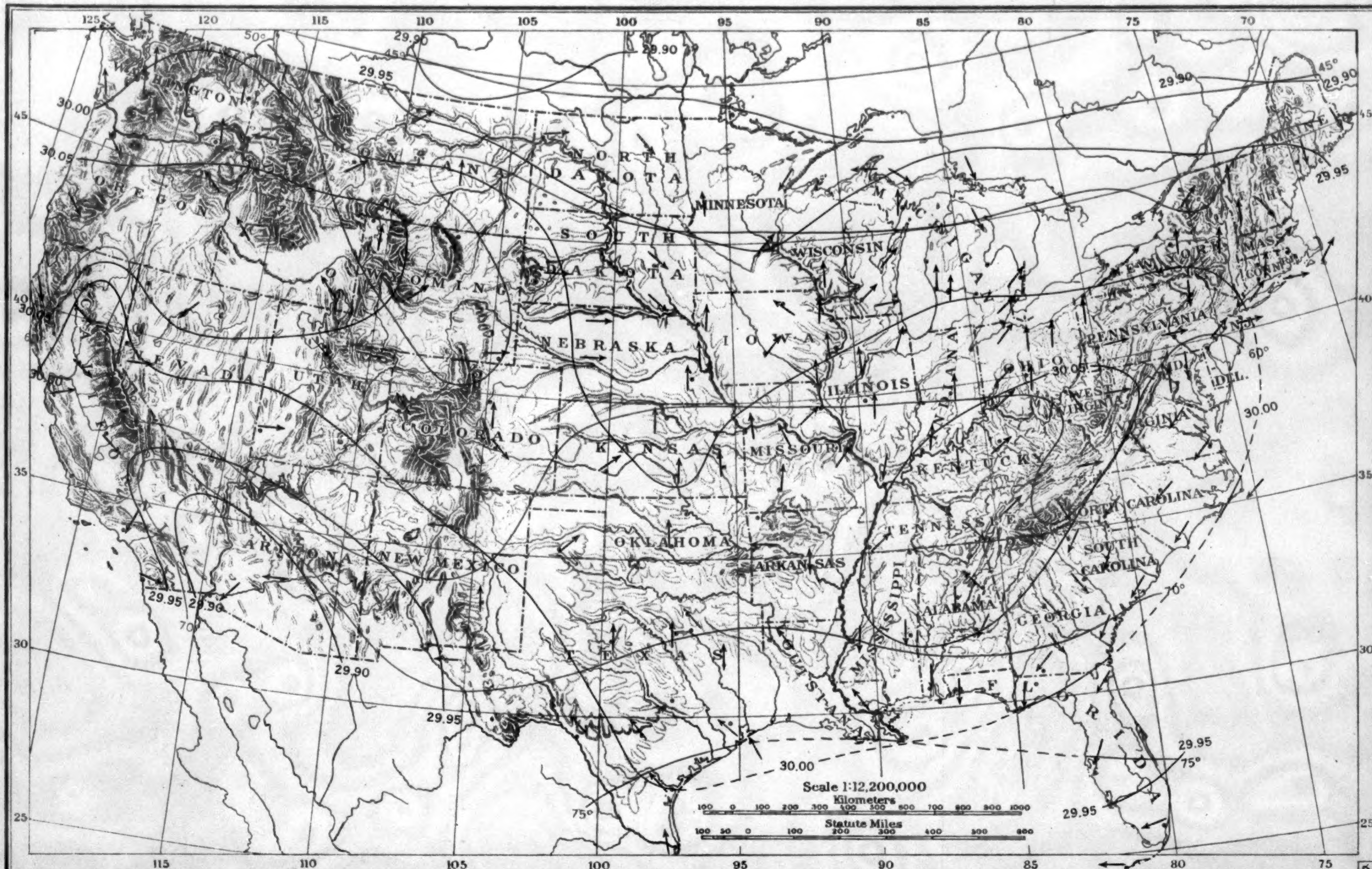


Chart VIII. Weather Map of North Atlantic Ocean, October 28, 1927
(Plotted by F. A. Young)

Chart VIII. Weather Map of North Atlantic Ocean, October 28, 1927
(Plotted by F. A. Young)

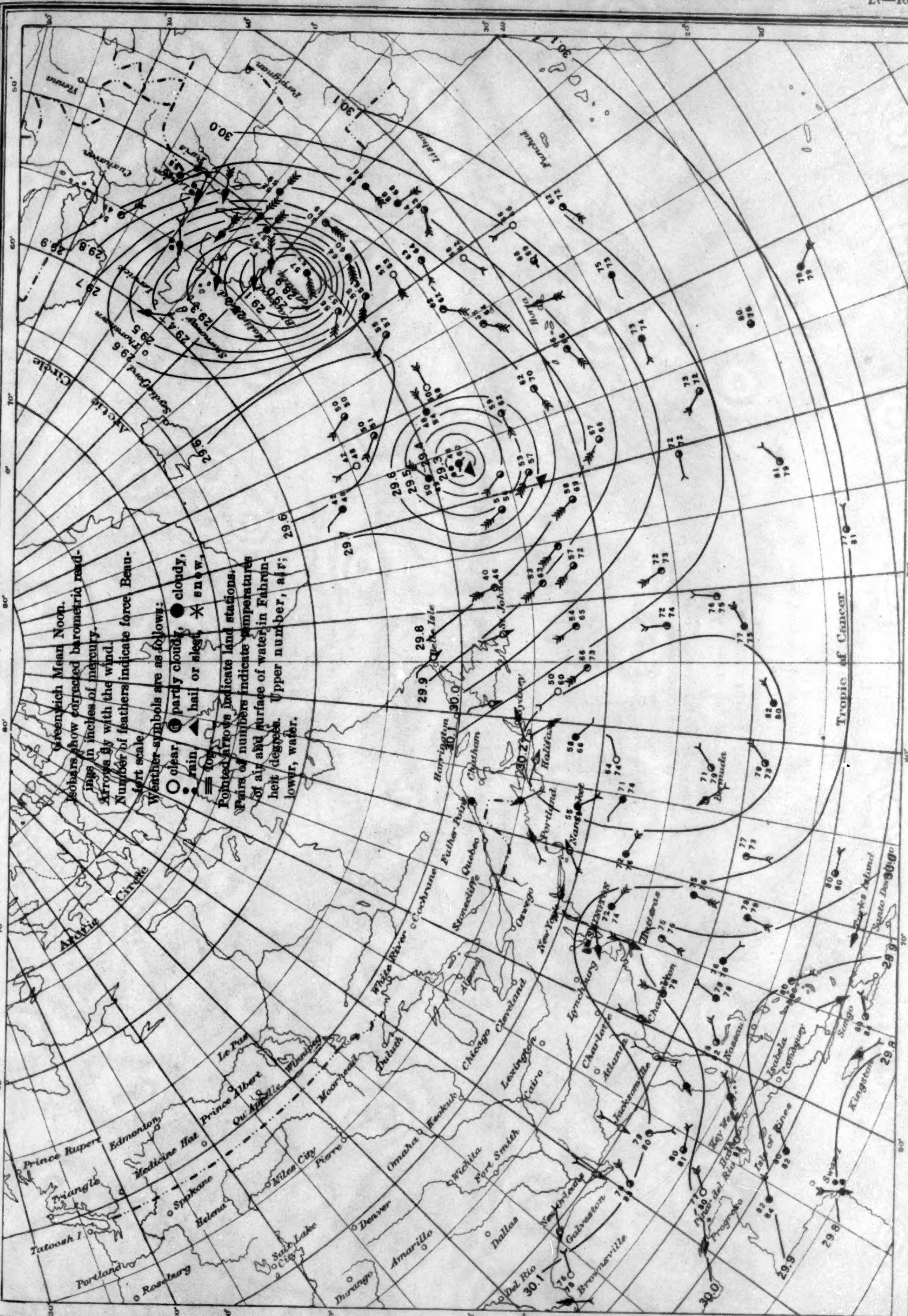


Chart IX. Weather Map of North Atlantic Ocean, October 29, 1927

(Plotted by F. A. Young)

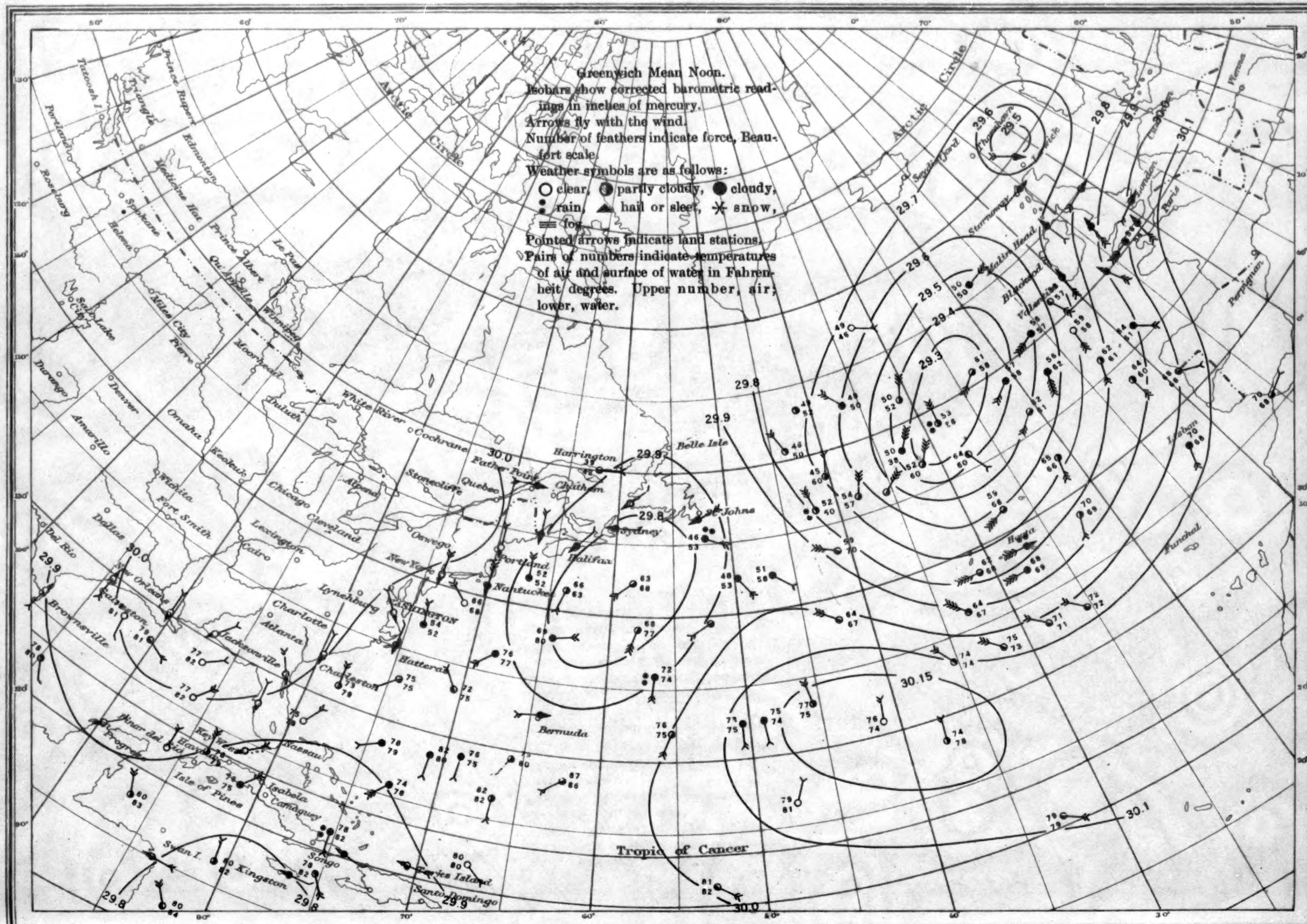


Chart X. Weather Map of North Atlantic Ocean, October 30, 1927

(Plotted by F. A. Young)

Chart X. Weather Map of North Atlantic Ocean, October 30, 1927

(Plotted by F. A. Young)

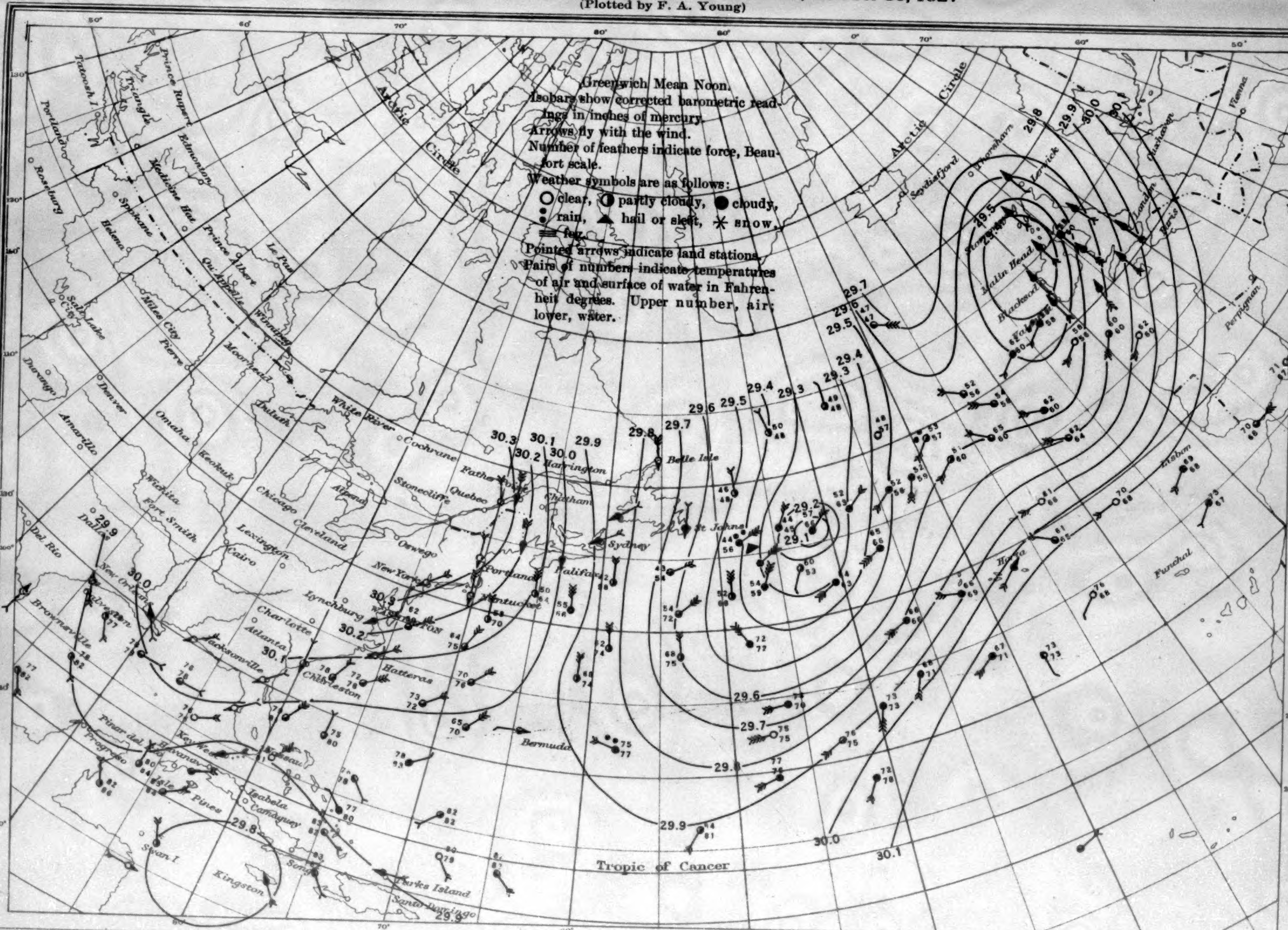


Chart XI. Weather Map of North Atlantic Ocean, October 31, 1927
(Plotted by F. A. Young)